

SOIL SURVEY OF

Sanpete Valley Area, Utah

Parts of Utah and Sanpete Counties



United States Department of Agriculture
Soil Conservation Service and
United States Department of the Interior
Bureau of Land Management
In cooperation with the
Utah Agricultural Experiment Station and
Utah State Department of Wildlife Resources

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all who need the information, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in the period 1964-70. Soil names and descriptions were approved in 1971. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1970. This survey was made cooperatively by the Soil Conservation Service and the United States Department of the Interior, Bureau of Land Management, the Utah Agricultural Experiment Station, and Utah State Department of Wildlife Resources. It is part of the technical assistance furnished to the Sanpete County and Nebo Soil Conservation Districts.

Soil maps in this survey may be copied without permission, but any enlargement of these maps could cause misunderstanding of the detail of mapping and result in erroneous interpretations. Enlarged maps do not show small areas of contrasting soils that could have been shown at a larger mapping scale.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms, ranches, and woodlands; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming, industry, and recreation.

Locating Soils

All the soils of the Sanpete Valley Area are shown on the detailed map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbols. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all the soils in the survey area in alphabetic order by map symbol and gives the capability classification of each. It also shows the page where each soil is described and the page for the range site in which the soil has been placed.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by

using the soil map and the information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils from the soil descriptions and from the discussions of the capability units and range sites.

Game managers, sportsmen, and others can find information about soils and wildlife in the section "Wildlife."

Ranchers and others can find, under "Range" groupings of the soils according to their suitability for range and also the names of many of the plants that grow on each range site.

Engineers, builders, and community planners can find, under "Engineering," tables that contain test data, estimates of soil properties, and information about soil features that affect engineering practices.

Scientists and others can read about how the soils formed and how they are classified in the section "Formation and Classification of Soils."

Newcomers in the Sanpete Valley Area may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the information about the survey area given at the beginning of the publication.

Cover: Landscape north of Manti with Manti Mountain in background. In the valley in the foreground are mainly Anco, Woodrow, and Genola soils. On the fans above the valley bottom is Sanpete cobbly fine sandy loam. On the hills in the background are Borvant and Fontreen soils.

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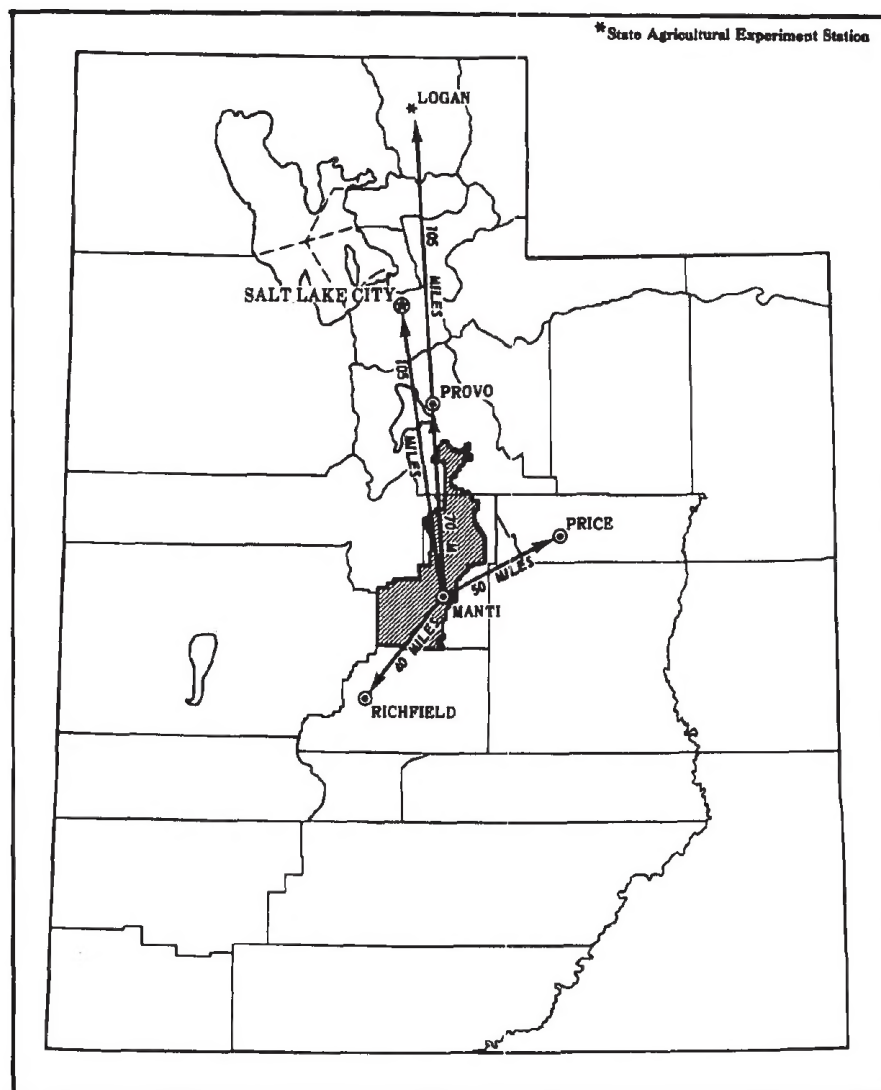
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Location of Sanpete Valley Area in Utah.

SOIL SURVEY OF SANPETE VALLEY AREA, UTAH

PARTS OF SANPETE AND UTAH COUNTIES

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THE SANPETE VALLEY AREA is mainly in Sanpete County but includes a part of Utah County (see facing page). The eastern boundary coincides with the western boundary of the Manti-La Sal National Forest and extends as far north as Spanish Fork Canyon. In the vicinity of Spanish Fork Canyon and Loafer Mountain, the survey area is bounded by the Uinta National Forest. The southern boundary is the Sanpete-Sevier County line; the western boundary is the Millard-Sanpete, Juab-Sanpete County lines and the eastern boundary of the Uinta National Forest from Wales north to Loafer Mountain.

The survey area covers 673,994 acres, or about 1,053 square miles. About 420,000 acres of this is range that includes the wet, meadow lands that may or may not be cut for wild hay once a year. An additional 156,000 acres is grazeable woodland. About 15,000 acres is woodland, and 83,000 acres is irrigated and nonirrigated general farmland.

The survey area is drained by the Spanish Fork, Sanpitch, and Sevier Rivers. The topography ranges from nearly level bottom land to very steep mountainsides. Elevation ranges mostly from 5,100 feet to about 9,200 feet. Some mountain peaks are slightly higher.

Manti, the county seat of Sanpete County, is in the southern part of the survey area and is the fourth oldest settlement in Utah. Other towns of about equal size are Gunnison, Ephraim, Mount Pleasant, Moroni, Fairview, and Fountain Green.

Farming is the main source of income. Most of the alfalfa, grain, and corn silage produced in the survey area is fed to feeder beef cattle and lambs or to dairy herds. The production of turkeys is also important in the survey area, but most of their feed is imported.

The principal industries are the manufacture of vacation trailers and campers, the processing of about 2 million turkeys annually, and the manufacture of jackets and other clothing.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soils are in the Sanpete Valley Area, where they are located, and how they can be used. They went into

the survey area knowing they would find some soils they had already seen, and perhaps many they had not. As they traveled over the area, they observed the steepness, length, and shape of slopes; the size of streams; the kinds of native plants or crops; the kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by roots of plants.

The soil scientists made comparisons among the profiles they studied and compared these profiles with those in nearby counties and more distant places. They classified and named the soils according to nationwide, uniform procedures. The *soil series* and the *soil phase* are the categories of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Moroni and Arapien, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Arapien fine sandy loam, 1 to 2 percent slopes, is one of several phases within the Arapien series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map at the back of this publication was prepared from aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. Three such kinds of mapping units are shown on the soil map of Sanpete Valley Area: soil complexes, soil associations, and undifferentiated groups.

A soil complex consists of areas of two or more soils, so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. Generally, the name of a soil complex consists of the name of the dominant soils, joined by a hyphen. Arapien-Calita complex, 2 to 15 percent slopes, is an example.

A soil association is made up of adjacent soils that occur as areas large enough to be shown individually on the soil map but are shown as one unit because the time and effort of delineating them separately cannot be justified. There is a considerable degree of uniformity in pattern and relative extent of the dominant soils, but the soils may differ greatly from one another. The name of an association consists of the names of the dominant soils, joined by a hyphen. Daybell-Fly-gare association, very steep, is an example.

An undifferentiated group is made up of two or more soils that could be delineated individually but are shown as one unit because, for the purpose of the soil survey, there is little value in separating them. The pattern and proportion of soils are not uniform. An area shown on the map may be made up of only one of the dominant soils, or of two or more. Quaker and Mellor soils is an undifferentiated soil group in this survey area.

In most areas surveyed there are places where the soil material is so rocky, so shallow, so severely eroded, or so variable that it has not been classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Rock land is a land type in this survey area.

While a soil survey is in progress, soil scientists take soil samples needed for laboratory measurements and for engineering tests. Laboratory data from the same kind of soil in other places are also assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kind of soil. Yields under defined management are estimated for all the soils.

Soil scientists observe how soils behave when used as a growing place for native and cultivated plants and as material for structures, foundations for structures, or covering for structures. They relate this behavior to properties of the soils. For example, they observe that filter fields for onsite disposal of sewage fail on a given kind of soil, and they relate this to the slow permeability of the soil or a high water table.

They see that streets, road pavements, and foundations for houses are cracked on a named kind of soil, and they relate this failure to the high shrink-swell potential of the soil material. Thus, they use observation and knowledge of soil properties, together with available research data, to predict limitations or suitability of soils for present and potential uses.

After data have been collected and tested for the key, or benchmark, soils in a survey area, the soil scientists set up trial groups of soils. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. They then adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under current methods of use and management.

General Soil Map

The General Soil Map included with this survey shows, in color, the soil associations in the Sanpete Valley Area. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another association, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in an area, who want to compare different parts of the area, or who want to know the location of large tracts of land that are suitable for a certain kind of farming or other land use. Such a map is not suitable for planning the management of a farm or field, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect management.

The 16 soil associations in this survey area are discussed in the following pages. The terms for texture used in the title of an association apply to the dominant texture of the subsoil or underlying material of the major soils in the association. This part of the soil exerts the most influence on root depth, available water capacity, drainage, and related characteristics. For more detailed information about the individual soils in each association, refer to the detailed map and to the section "Descriptions of the Soils."

Dominantly Well Drained and Somewhat Excessively Drained, Nearly Level to Steep, Deep Soils on Flood Plains, Alluvial Fans, and Valley Bottoms

The soils in this group are on flood plains, alluvial fans, and valley bottoms in Gunnison Valley, Sanpete Valley, and Indianola Valley, and on the Fountain Green Divide. These soils formed in alluvium from limestone, sandstone, and shale.

1. Genola-Woodrow-Quaker association

Well drained, nearly level to strongly sloping, deep silty clay loams, clay loams, and loams on flood plains, alluvial plains, and alluvial fans in the valleys

This association is above the lowest bottom lands in Gunnison and Sanpete Valleys. The soils are nearly level to strongly sloping, deep, and well drained. They formed in alluvium derived from limestone, sandstone, and shale. Vegetation is big sagebrush, shadscale, rabbitbrush, and perennial grasses. Elevation ranges from 5,000 to 6,500 feet. The average annual precipitation ranges from 8 to 12 inches, and the average annual air temperature ranges from 45° to 51° F. The frost-free period is 115 to 130 days.

This association makes up about 7 percent of the survey area. It is 30 percent Genola soils, 30 percent Woodrow soils, 20 percent Quaker soils, and 20 percent less extensive soils. The less extensive Linoyer soils are about 15 percent of the association, and Centerfield and Wales soils together make up about 5 percent.

Woodrow soils are throughout the association but are extensive north of Axtell. They have a surface layer of silty clay loam and a substratum of clay loam. Genola soils are most common southwest of Gunnison. They have a surface layer of loam and a substratum of stratified loam to very fine sandy loam. Quaker soils are most extensive in Flat Canyon and around Pigeon Hollow. They have a surface layer and substratum of silty clay loam.

These soils are used mainly for irrigated alfalfa, small grain, corn for silage, and pasture. Quaker soils are also used for nonirrigated wheat and grass. All of the soils provide habitat for upland game birds.

2. Arapien-Sanpete-Lisade association

Somewhat excessively drained to moderately well drained, gently sloping to strongly sloping, deep clay loams, loams, very gravelly sandy loams, gravelly sandy loams, and sandy loams on the higher alluvial fans and alluvial plains

This association is in Gunnison and Sanpete Valleys. The soils are gently sloping to strongly sloping, deep, somewhat excessively drained to moderately well drained. They formed in alluvium derived from sandstone, limestone, and shale. Vegetation is rabbitbrush, big sagebrush, and perennial grasses. Elevation ranges from 5,000 to 6,000 feet. The average annual precipitation ranges from 8 to 12 inches, and the average annual air temperature ranges from 45° to 52° F. The frost-free period is 115 to 130 days.

This association makes up about 5 percent of the survey area. It is about 35 percent Arapien soils, 30 percent Sanpete soils, and 15 percent Lisade soils. Denmark and Freedom soils make up about 10 percent each.

Arapien soils are on the lower part of alluvial fans. They have a surface layer of fine sandy loam and a substratum of clay loam and loam. Sanpete soils are on the upper part of the alluvial fans. They have a surface layer of gravelly fine sandy loam and gravelly loam and a substratum of very gravelly sandy loam. Lisade soils are on the middle parts of the alluvial fans. They have a surface layer of loam and a substratum of gravelly sandy loam and sandy loam.

The Arapien and Lisade soils are used mainly for irrigated alfalfa, small grain, corn for silage, and pasture. They are also used as range. Sanpete soils are used mainly as winter and spring range. They are also

a source of road fill. All of the soils are used as habitat by upland game birds.

3. Sanpete-Sigurd association

Somewhat excessively drained, moderately sloping to steep, deep gravelly sandy loams and very gravelly sandy loams on highest alluvial fans, flood plains, or alluvial plains in the valleys

This association is mostly on the western side of Gunnison Valley and extends from the Sevier Bridge Reservoir south to the Sevier-Sanpete County line. The soils are moderately sloping to steep. They are deep and somewhat excessively drained. They formed in alluvium derived from sandstone, limestone, and shale. Vegetation is big sagebrush, shadscale, yellowbrush, and perennial grasses. Elevation ranges from 5,000 to 6,600 feet. The average annual precipitation ranges from 8 to 13 inches, and the average annual air temperature ranges from 45° to 49° F. The frost-free period is 110 to 130 days.

This association makes up about 7 percent of the survey area. It is about 60 percent Sanpete soils and 30 percent Sigurd soils. Rapho soils and Torrifluvents and Torriorthents, stony, make up the remaining 10 percent.

Sanpete soils are in the higher areas. They have a surface layer of gravelly fine sandy loam and gravelly loam and a substratum of very gravelly sandy loam. Sigurd soils are in lower areas. They have a surface layer of gravelly loam and a substratum of very gravelly sandy loam and gravelly sandy loam.

This association is used mainly for livestock grazing and as habitat for small game and upland game birds. Water for livestock can usually be obtained from nearby canals, but occasionally it is necessary to haul water for grazing livestock. The association is also a source of road fill.

4. Birdow-Keigley-Doyce association

Well drained and moderately well drained, gently sloping to strongly sloping, deep very fine sandy loams, silty clay loams, and sandy clay loams on alluvial fans, flood plains, and alluvial plains

This association is most extensive between Moroni and Fairview and in the Indianola Valley. The soils are gently sloping to strongly sloping, generally smooth, deep, and well drained and moderately well drained. They formed in alluvium derived from sandstone, quartzite, limestone, and shale. Vegetation is big sagebrush, rabbitbrush, and perennial grasses. Elevation ranges from 5,400 to 6,100 feet. The average annual precipitation ranges from 11 to 14 inches, and the average annual air temperature ranges from 45° to 48° F. The frost-free period is 100 to 130 days.

This association makes up about 4 percent of the survey area. It is about 25 percent Birdow soils, 20 percent Doyce soils, 20 percent Keigley soils, and 35 percent less extensive soils. The less extensive Collard and Moroni soils make up about 10 percent each, and the Arapien, Calita, and Snake Hollow soils make up the remaining 15 percent.

Birdow soils are in small areas throughout the association. They have a surface layer of very fine sandy

loam and are underlain by loam. Keigley soils are on bottom land. They have a surface layer and substratum of silty clay loam. Doyce soils are mainly east and north of Freedom. They have a surface layer of loam, a subsoil of sandy clay loam, and a substratum of sandy clay loam and loam.

This association is used mainly for irrigated alfalfa, small grain, and pasture. It is also used as range. Some areas of Collard soils are a source of sand and gravel used in road construction.

5. Manila-Ant Flat-Deer Creek association

Well drained, moderately sloping to steep, deep silty clays and clays on alluvial fans, alluvial plains, and lower mountain slopes

This association is mainly on the Fountain Green Divide and at Millburn and Birdseye. The soils are moderately sloping to steep, generally smooth, deep, and well drained. They formed in alluvium and colluvium derived from sandstone, quartzite, limestone, shale, and mixed igneous rocks. Vegetation is oakbrush, big sagebrush, and perennial grasses. Elevation ranges from 5,600 to 7,000 feet. The average annual precipitation ranges from 14 to 18 inches, and the average annual air temperature ranges from 38° to 45° F. The frost-free period is 80 to 100 days.

This association makes up about 3 percent of the survey area. It is about 30 percent Manila soils, 25 percent Ant Flat soils, and 20 percent Deer Creek soils. The Toehead and Watkins Ridge soils make up about 10 percent each, and the Bezzant soils make up the remaining 5 percent.

Manila soils are extensive on the Fountain Green Divide. They have a surface layer of silt loam and a subsoil of silty clay and clay. Ant Flat soils are also extensive on the Fountain Green Divide. They have a surface layer of loam and silt loam, a subsoil of silty clay, and a substratum of loam. Deer Creek soils have a surface layer of stony silt loam, a subsoil of stony clay, and a substratum of cobbly clay loam.

The Ant Flat, Manila, Toehead, and Watkins Ridge soils are used for nonirrigated alfalfa, small grain, and pasture. They are also used as range. The Toehead and Watkins Ridge soils are also used for irrigated alfalfa, small grain, and pasture. Deer Creek soils are used mainly as range.

Dominantly Well Drained and Somewhat Excessively Drained, Gently Sloping to Very Steep, Shallow and Deep Soils and Rock Land on the Higher Alluvial Fans, Foothills, Upland Plateaus, and Lower Mountain Slopes

The soils in this group are on the higher alluvial fans, foothills, upland plateaus, and lower mountain slopes, in the Valley Mountains, the lower part of the Gunnison Plateau, and on the east and west sides of Sanpete Valley. These soils formed in residuum, colluvium, and alluvium from limestone, sandstone, and shale.

6. Fontreen-Lodar-Borvant association

Somewhat excessively drained, moderately sloping to

very steep, deep and shallow very gravelly loams on ridges, lower mountain slopes, alluvial fans, and foothills

This association is in the Valley Mountains west of Gunnison and along the eastern side of the survey area. It extends from Mayfield north to Ephraim and in the area north of Fairview. The soils are moderately sloping to very steep, deep to shallow, and somewhat excessively drained. They formed in alluvium, residuum, and colluvium derived from limestone, sandstone, chert, and shale. Vegetation is dominantly juniper, pinon, big sagebrush, yellowbrush, and perennial grasses. Elevation ranges from 5,600 to 7,000 feet. The average annual precipitation ranges from 11 to 14 inches, and the average annual air temperature ranges from 43° to 47° F. The frost-free period is 90 to 110 days.

This association makes up about 12 percent of the survey area. It is about 50 percent Fontreen soils, 25 percent Lodar soils, and 20 percent Borvant soils. Wales soils and Rock land make up the remaining 5 percent.

Fontreen soils are on mountainsides and alluvial fans. They have a surface layer of very cobbly and very gravelly loam and a substratum of very gravelly loam. Lodar soils are on ridges and mountainsides. They are shallow and have a surface layer of very channery loam underlain by very gravelly loam that is 10 to 20 inches deep over bedrock. Borvant soils are on alluvial fans and foothill slopes. They are shallow and have a surface layer of gravelly and cobbly loam underlain by very gravelly loam that is 10 to 20 inches deep over an indurated lime hardpan.

This association is used for pasture and as winter range by deer. It is also used for woodland. Juniper is cut for fenceposts, and dead pinon and juniper are gathered for firewood.

7. Amtoft-Sanpete-Rock land association

Somewhat excessively drained, gently sloping to very steep, shallow and deep flaggy loams and very gravelly sandy loams and Rock land on alluvial fans and foothills

This association is north of Gunnison and southwest of Spring City. The soils are gently sloping to very steep, shallow and deep, and somewhat excessively drained. They formed in alluvium, residuum, and colluvium derived mainly from limestone. Vegetation is dominantly shadscale, big sagebrush, yellowbrush, and perennial grasses. Elevation ranges from 5,100 to 6,600 feet. The average annual precipitation ranges from 8 to 13 inches, and the average annual air temperature ranges from 45° to 49° F. The frost-free period is 100 to 130 days.

This association makes up about 5 percent of the survey area. It is about 65 percent Amtoft soils, 20 percent Sanpete soils, and 10 percent Rock land. Rapho and Linoyer soils make up the remaining 5 percent.

Amtoft soils are common throughout the association. They are shallow and have a surface layer of flaggy loam and very flaggy loam and a substratum of flaggy loam that is 10 to 20 inches deep over limestone. Sanpete soils are common on the alluvial fans

throughout the association. They are deep and have a surface layer of gravelly fine sandy loam and gravelly loam that is underlain by very gravelly sandy loam. Rock land is on the ridges and points. It is mainly rock outcrop, and in places a thin mantle of soil covers the bedrock.

This association is used as spring and fall range by sheep and cattle. The Sanpete soils are also a source of road fill.

8. Rock land-Atepic-Amtoft association

Rock land and well drained and somewhat excessively drained, strongly sloping to very steep, shallow flaggy loams and shaly silty clay loams on upland plateaus

This association is on very steep canyon side slopes and ridges on uplands, mainly northeast of Fayette and on the eastern slope of the West Mountains in Sanpete Valley. The soils are strongly sloping to very steep, shallow, well drained and somewhat excessively drained. They formed in alluvium derived from shale and limestone. Vegetation is juniper, shadscale, Mormon tea, and perennial bunchgrasses. Elevation ranges from 5,200 to 7,200 feet. The average annual precipitation ranges from 8 to 15 inches, and the average annual air temperature ranges from 45° to 48° F. The frost-free period is 100 to 130 days.

This association makes up about 11 percent of the survey area. It is about 50 percent Rock land, 30 percent Atepic soils, and 15 percent Amtoft soils. Lodar and Borvant soils make up the remaining 5 percent.

Rock land is mainly on ridges and very steep side slopes. It is mainly outcrops of sandstone, shale, or limestone and stones or boulders dislodged from the outcrops. A thin soil mantle covers the bedrock in places. Atepic soils are throughout the association but are usually at the higher elevations. They have a surface layer of shaly clay loam underlain by shaly silty clay loam that is 10 to 20 inches deep over shale. Amtoft soils are most common on the lower foothill slopes. They have a surface layer of flaggy loam underlain by flaggy and very flaggy loam that is 10 to 20 inches deep over bedrock.

This association is used as spring and fall range by sheep and as winter range by deer. Water supplies for livestock are limited, and hauling water by truck is sometimes necessary. Atepic soils are used for woodland. Juniper is used for posts, and dead pinon and juniper are used for firewood.

9. Borvant-Mountainville-Doyce association

Somewhat excessively drained to moderately well drained, gently sloping to steep, deep and shallow very gravelly loams, very stony sandy clay loams, and sandy clay loams on alluvial fans and foothills

This association is in Sanpete Valley, mainly in the area east of Spring City and Mount Pleasant. The soils are gently sloping to steep and are generally smooth. They formed in alluvium or colluvium derived from sandstone, limestone, quartzite, and shale. Vegetation is big sagebrush, juniper, pinon, yellowbrush, bitterbrush, and perennial grasses. Elevation ranges from 5,600 to 6,700 feet. The average annual precipitation ranges from 11 to 14 inches, and the average annual

air temperature ranges from 45° to 47° F. The frost-free period is 90 to 120 days.

This association makes up about 4 percent of the survey area. The Borvant and Mountainville soils make up about 25 percent each, and Doyce soils about 20 percent of the association. Pavant and Donnardo soils make up 15 percent each.

Borvant soils are extensive in the Denmark Cedars area south and east of Spring City. They have a surface layer of cobbly and gravelly loam underlain by very gravelly loam that is 20 inches deep over an indurated limestone hardpan. Mountainville soils are east of Mount Pleasant. They have a surface layer of very stony sandy loam and fine sandy loam, a subsoil of very stony sandy clay loam, and a substratum of very stony loam. Doyce soils are in swales and depressions. They have a surface layer of loam, a subsoil of sandy clay loam, and a substratum of sandy clay loam and loam.

This association is used mainly as spring and fall range by sheep and cattle and by deer during winter. Some Doyce soils are used for irrigated alfalfa, small grain, and as pasture. Borvant soils are a source of road fill. The juniper growing on the Borvant soils can be harvested for fenceposts or firewood.

Dominantly Well Drained, Gently Sloping to Moderately Sloping, Deep, Saline Soils on Alluvial Fans, Alluvial Plains, and Valley Bottoms, and Badland

The soils in this group are on alluvial fans, alluvial plains, and valley bottoms in the southeastern part of the survey area. These soils formed in alluvium and colluvium from shale.

10. Badland-Skumpah association

Badland and well drained, gently sloping to moderately sloping, deep silty clay loams on alluvial fans, alluvial plains, and valley bottoms

This association is west of the town of Mayfield. The soils are gently sloping to moderately sloping, generally smooth, deep, and well drained. They formed in alluvium derived mainly from shale. The Badland consists of strongly sloping to very steep hills west of Mayfield. Vegetation is dominantly shadscale, yellowbrush, greasewood, and scattered juniper. Elevation ranges from 5,000 to 6,000 feet. The average annual precipitation ranges from 8 to 12 inches, and the average annual air temperature ranges from 45° to 52° F. The frost-free period is 115 to 130 days.

This association makes up about 3 percent of the survey area. It is about 55 percent Badland and 20 percent Skumpah soils. Mayfield and Ravola soils make up about 10 percent each, and Billings soils make up the remaining 5 percent.

Badland consists of nearly bare, strongly sloping to very steep, actively eroding shale hills. Runoff from storms and rapid snowmelt produces much silt. Skumpah soils are most extensive in the southern part of the association southeast of Axtell. They have a surface layer of silt loam, a subsoil of silty clay loam,

and a substratum of silt loam. These soils typically have varying amounts of gypsum.

Badland is used mainly as habitat by wildlife. Skumpah soils are used mainly as range and as habitat by upland game birds. They are especially unstable for construction uses and are subject to differential settlement if they are irrigated.

Dominantly Poorly Drained, Nearly Level to Moderately Sloping, Deep Soils on Flood Plains, Lake Terraces, and Alluvial Fans

The soils in this group are on flood plains, lake terraces, and alluvial fans, along the Sevier and Sanpitch River bottoms. These soils formed in alluvium from limestone and sandstone and mixed lake sediments, or both.

11. Xerofluvents and Fluvaquent-Mellor association

Well drained to poorly drained, nearly level to moderately sloping, deep, nonsaline to strongly saline, stratified loamy sands to clays on the flood plains, lake terraces, and alluvial fans

This association is along the Sevier River in Gunnison Valley and on the alluvial fans and lake terraces above the lowest bottom lands in Gunnison and Sanpete Valleys. The soils are nearly level to moderately sloping, generally smooth, deep, and well drained to poorly drained. They formed in alluvium derived from limestone, sandstone, and shale. These soils are nonsaline to strongly saline. Vegetation in the nonsaline or slightly saline areas is bluegrass, wiregrass, willows, and rubber rabbitbrush. Saltgrass, alkali sacaton, pickleweed, greasewood, and bassia grow in the moderately saline and strongly saline areas. Elevation ranges from 5,000 to 6,000 feet. The average annual precipitation ranges from 8 to 12 inches, and the average annual air temperature ranges from 45° to 51° F. The frost-free period is 110 to 140 days.

This association makes up about 5 percent of the survey area. It is about 35 percent Xerofluvents and Fluvaquents, 20 percent Mellor soils, and 15 percent Dyreng soils. The Manassa, Harding, and Quaker soils make up about 10 percent each.

Xerofluvents and Fluvaquents are throughout the association. They are stratified loamy sand to clay but are dominantly sandy loam to clay loam. Mellor soils are extensive near Fayette but are throughout the association. They have a surface layer of silt loam, a subsoil of silty clay loam, and a substratum of stratified silty clay loam, silt loam, and silty clay.

This association is used mainly as spring and late fall range for sheep and cattle. Water for livestock is usually available. Dyreng soils are used for irrigated alfalfa, small grain and corn, and as pasture. Small areas are used as range. All of the soils of the association are used as habitat by upland game birds and some waterfowl.

12. Poganeab-Shumway-Chipman association

Poorly drained, nearly level to gently sloping, deep silty clay loams and silty clays on flood plains and alluvial fans in the valley bottoms

This association is on flood plains and alluvial fans in the bottom areas of Sanpete and Indianola Valleys. The soils are nearly level to gently sloping, generally smooth, deep, and poorly drained to somewhat poorly drained. They formed in alluvium derived from limestone, sandstone, and shale. Some of these soils are moderately saline to strongly saline. Vegetation is dominantly wiregrass, sedges, rushes, and saltgrass. Elevation ranges from 5,100 to 6,100 feet. The average annual precipitation ranges from 8 to 14 inches, and the average annual air temperature ranges from 43° to 49° F. The frost-free period is 100 to 130 days.

This association makes up about 7 percent of the survey area. It is about 15 percent Poganeab soils and 10 percent each Shumway, Chipman, and Abcal soils and Fluvaquents. Kjar, Peteetneet, Ephraim, Beek, Poganeab variant, Canburn, and Green River soils make up the remaining 45 percent. They are similar in texture and drainage characteristics to the major soils.

Poganeab soils are most common on the bottom lands west of Chester. They have a surface layer of silt loam and silty clay loam that is underlain by silty clay loam. Shumway soils are most extensive north and west of Manti. They have a surface layer of silty clay loam, a subsoil of silty clay, and are underlain by silty clay and clay. Chipman soils are most common between Moroni and Fairview along the San Pitch river bottoms and between Moroni and Fountain Green. They are silty clay loam throughout.

This association is used as native grass pasture and for hay. It is also used as a nesting place for both waterfowl and upland game birds. Muskrats use some of the wettest areas.

Dominantly Well Drained and Somewhat Excessively Drained, Moderately Sloping to Very Steep, Shallow to Deep Soils on Mountains, and Rock Land

The soils in this group are on low to high mountains in the eastern, western, and northern parts of the survey area. These soils formed in residuum, alluvium, and colluvium derived from many kinds of rocks.

13. Lizzant-Mower-Lundy association

Well drained and somewhat excessively drained, moderately sloping to very steep, deep to shallow cobbly loams, silty clay loams, and very flaggy clay loams on broad ridges and mountains

This association is on the mountain areas of the Gunnison Plateau and on a narrow strip of the eastern edge of the survey area that extends from the Sanpete-Sevier County line north to Milburn. The soils are moderately sloping to strongly sloping on the broad ridges and sagebrush flats, and steep to very steep on the mountainsides. These soils are deep to shallow and well drained and somewhat excessively drained. They formed in alluvium derived from limestone, sandstone, and shale. Vegetation is dominantly oakbrush, big sagebrush, and perennial grasses. Elevation ranges from 6,500 to 8,000 feet. The average annual precipitation ranges from 14 to 20 inches, and the average annual

air temperature ranges from 43° to 45° F. The frost-free period is 80 to 110 days.

This association makes up about 9 percent of the survey area. It is about 45 percent Lizzant soils, 20 percent Mower soils, and 10 percent Lundy soils. The Kitchell soils also make up about 10 percent, and the less extensive Clegg, Sedwell, and Deer Creek soils make up the remaining 15 percent.

Lizzant soils are on hillsides and are common throughout the association. They have a surface layer of very cobbly loam, a subsoil of cobbly loam, and a substratum of very gravelly and very stony loam. Mower soils are most extensive on the sagebrush flats of the West Mountain and Gunnison Plateau. They have a surface layer of clay loam, a subsoil of heavy silty clay loam, and a substratum of shaly silty clay loam. Bedrock is at a depth of 20 to 40 inches. Lundy soils are on the ridges. They have a surface layer of channery silt loam that is underlain by very flaggy light clay loam. Bedrock is at a depth of 10 to 20 inches.

Lizzant, Mower, and Lundy soils are used as range by sheep, cattle, deer, and elk. Kitchell soils are used for woodland, especially Douglas-fir and concolor fir. They are also used as summer habitat by deer and elk.

14. Daybell-Bezzant-Rock land association

Well drained and somewhat excessively drained, very steep, deep very gravelly very fine sandy loams and very cobbly loams and Rock land on mountains

This association is on the sides of high mountains and canyons near Loafer Mountain. The Rock land consists of many nearly perpendicular ledges, areas at the bottoms of the ledges covered by stones and boulders, and slopes that have a thin mantle of soil over bedrock. The Daybell and Bezzant soils are very steep, deep, well drained and somewhat excessively drained. They formed in alluvium or colluvium derived from sandstone and limestone. Vegetation is aspen, conifer, oakbrush, snowberry, and perennial grasses. Elevation ranges from 5,400 to 9,000 feet. The average annual precipitation ranges from 16 to 30 inches, and the average annual air temperature ranges from 40° to 44° F. The frost-free period is 70 to 90 days.

This association makes up about 3 percent of the survey area. The Daybell soils, Bezzant soils, and Rock land make up about 20 percent each. The Gappmayer soils make up about 15 percent, and the Flygare soils make up about 10 percent. Less extensive Tingey, Bradshaw, Adel, and Cheadle soils make up the remaining 15 percent.

Daybell soils are mainly on the north-facing slopes. They have a surface layer of gravelly silt loam that is underlain by very gravelly very fine sandy loam and fine sandy loam. Bezzant soils are on the south-facing slopes. They have a surface layer of stony loam and gravelly loam that is underlain by very cobbly loam.

Daybell soils are used for woodland. Dominant vegetation on the Daybell soils is aspen that has an understory of grasses and forbs. Many areas of this association are too steep and too rough for grazing sheep and cattle. Most areas of the Daybell soils and some of the less extensive soils are used as summer range by sheep, cattle, deer, and elk. They are also used as water catchment areas. All of the soils are a fair to

good source for road fill. Roads are difficult to build and to maintain because of the steep slopes and rock outcrops.

15. Deer Creek-Bagard-Yeates Hollow association

Well drained, moderately sloping to very steep, deep cobbly, stony, and very stony clays and clay loams on mountain foot slopes

This association is in canyons and on plateaus that extend from Fountain Green north to Thistle. The soils are moderately sloping to very steep, deep, and well drained. They formed in alluvium and colluvium derived from sandstone, quartzite, shale, mixed igneous material, and limestone. Vegetation is juniper, pinon, oakbrush, big sagebrush, and perennial grasses. Elevation ranges from 5,500 to 8,000 feet. The average annual precipitation ranges from 12 to 20 inches, and the average annual air temperature ranges from 38° to 45° F. The frost-free period is 70 to 100 days.

This association makes up about 12 percent of the survey area. It is about 25 percent Deer Creek soils, 20 percent Bagard soils, 15 percent Yeates Hollow soils, and about 40 percent less extensive soils. The Obrast and Sanpitch soils make up about 10 percent each, and the less extensive Bezzant, Harkers, and Ant Flat soils make up the remaining 20 percent.

Deer Creek soils are extensive west of Hilltop but are throughout the association. They have a surface layer of stony silt loam, a subsoil of stony and cobbly clay, and a substratum of cobbly clay loam. Bagard soils are east of Fountain Green. They have a surface layer of very stony clay loam, a subsoil of cobbly and very cobbly clay, and a substratum of very cobbly loam and sandy clay loam. Yeates Hollow soils are at the highest elevations. They have a surface layer of stony silt loam and silty clay loam and a subsoil of stony and very stony clay.

This association is used mainly as spring and summer range by sheep, cattle, and deer. Water for livestock is usually available from springs, streams, or constructed watering ponds. Sometimes water is hauled to reduce livestock congestion. Bagard soils are also used as juniper and pinon woodland.

16. Skylick-Mortenson-Tingey association

Well drained, moderately sloping to very steep, deep clay loams, cobbly and stony clay loams, and very stony clays on mountains

This association is on mountains, canyons, and plateaus east of Mount Pleasant. It also is on Mount Baldy west of Indianola. The soils are moderately sloping to very steep, deep, and well drained. They formed in alluvium and colluvium derived from sandstone and limestone. Vegetation is aspen, conifers, oakbrush, snowberry, and perennial grasses. Elevation ranges from 6,700 to 9,700 feet. The average annual precipitation ranges from 20 to 35 inches, and the average annual air temperature ranges from 38° to 45° F. The frost-free period is 70 to 90 days.

This association makes up about 3 percent of the survey area. It is about 30 percent Skylick soils, 25 percent Mortenson soils, and 10 percent Tingey soils. The Pritchett, Toze, and Zeesix soils each make up

about 10 percent, and the less extensive Gothic soils make up about 5 percent.

Skylick soils are throughout the association and are mainly on north-facing slopes. They have a surface layer of silt loam and a subsoil of clay loam and cobbly clay loam. Mortenson soils are on very steep, north-facing slopes east of Mount Pleasant. They have a surface layer of silt loam and stony silt loam and a subsoil of very stony clay. Tingey soils are on south-facing slopes east of Mount Pleasant. They have a surface layer of stony silt loam, a subsoil of stony clay loam and sandy clay loam, and a substratum of stony and very stony loam.

This association is used mainly as summer range by sheep, cattle, deer, and elk. Skylick and Mortenson soils are also used for woodland. Woodland species are mainly aspen on the Skylick soils and are mainly Douglas-fir, concolor fir, spruce, and scattered aspen on the Mortenson soils. This association is a water catchment area for watersheds.

Descriptions of the Soils

This section describes the soil series and mapping units of the Sanpete Valley Area. The acreage and proportionate extent of each mapping unit are given in table 1.

The procedure in this section is to first describe each soil series, and then describe the mapping units in that series. Thus, to get full information on any one mapping unit, it is necessary to read both the description of that unit and the description of the soil series to which it belongs.

The soil series descriptions are divided into three parts. The first part presents in general terms some of the soil characteristics such as depth, drainage, topography, climate, texture, and available water capacity. The second part presents a detailed soil profile description in technical terms. The last part presents the range of characteristics or variations in the series.

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Badland, Gullied land, Rock land, and Shaly colluvial land are miscellaneous land types. Cryoborolls, Fluvaquents, Torrifluvents and Torriorthents, stony, Xerofluvents and Fluvaquents, and Xerofluvents and Fluvaquents, saline, are soils named at higher categories; nevertheless, these are listed in alphabetical order along with the series.

The soils in this survey area were not all mapped at equal intensity, or degree of precision. The mapping units for soils that are cultivated, or mostly cultivated, contain less than 25 percent soils other than those named and have been mapped at high intensity. The mapping units for soils used mainly as range have less precise boundaries, wider slope range, and more variability in the kinds of soils included. These are mapped at low intensity. The intensity of the mapping is indicated by the soil symbol before the name of each mapping unit. If the second letter of a symbol is a small letter, the soils were mapped at high intensity; if a capital, they were mapped at low intensity.

Some soils in the survey area contain quantities of

soluble salts or alkali, or quantities of both. In some soils the concentration of salts and alkali is moderate to high. Low areas receive salty runoff or seepage water from higher surrounding areas. When the water evaporates, the salts remain and the soil becomes saline or saline-alkali. These soils are identified as saline or alkali phases in the mapping unit name, for example, Genola loam, alkali, 0 to 2 percent slopes.

Unless stated otherwise, the colors shown in this section are those of a dry soil. Color designations are those of the Munsell system.

Listed at the end of each description of a mapping unit is the capability unit and range site in which the mapping unit has been placed. The page on which each capability unit and range site is described can be found by referring to the "Guide to Mapping Units" at the back of this survey.

Soil scientists, engineers, students, and others interested in the origin and classification of the soils should turn to the section "Formation and Classification of Soils." Many terms used in the soil descriptions and other sections are defined in the Glossary and in the "Soil Survey Manual" (7).¹

Abcal Series

The Abcal series consists of poorly drained soils that formed in alluvium derived from shale, limestone, and sandstone on flood plains and valley bottoms. These soils are commonly associated with Cache, Ephraim, Anco, and Shumway soils. Slopes range from 0 to 2 percent.

Elevation ranges from 5,100 to 5,800 feet. The average annual precipitation is 8 to 12 inches, and the mean annual air temperature ranges from 45° to 49° F. The frost-free period ranges from 115 to 130 days. The native vegetation is wiregrass, sedges, saltgrass, and greasewood.

In a representative profile the surface layer is light brownish-gray silty clay loam about 3 inches thick. The substratum is light-gray heavy silty clay loam to a depth of 13 inches, white clay to a depth of 39 inches, and white clay and silty clay to a depth of 60 inches.

The Abcal soils are strongly calcareous and are moderately alkaline to very strongly alkaline throughout. Some are strongly saline-alkali. Permeability is slow. The root zone is 5 feet or more. The seasonal water table fluctuates between the surface and a depth of 40 inches.

These soils are chiefly used for native grass pasture or hay. Some areas are suitable nesting places for waterfowl and upland game birds. Muskrats are common in the low, wetter areas.

Representative profile of Abcal silty clay loam, in a native grass pasture, about 1,815 feet south and 2,145 feet west of the northeast corner of sec. 14, T. 18 S., R. 2 E., about 2 miles south of Manti, 1 mile south of Crystal Springs on the west side of the highway, Sanpete County:

¹ Italic numbers in parentheses refer to References, p. 176.

TABLE 1.—Approximate acreage and proportionate extent of soils

Soil	Acres	Percent	Soil	Acres	Percent
Abcal silty clay loam.....	2,960	0.4	Collard stony sandy loam, 4 to 20 percent slopes.....	620	.1
Abcal silty clay loam, strongly saline.....	555	.1	Crestline fine sandy loam, 2 to 5 percent slopes.....	545	.1
Abcal-Cache complex.....	1,120	.2	Cryoborolls.....	840	.1
Adel silt loam, 40 to 80 percent slopes.....	1,220	.2	Daybell gravelly silt loam, 40 to 70 percent slopes.....	1,455	.2
Amtoft flaggy loam, 8 to 30 percent slopes.....	19,970	3.0	Daybell-Flygare association, very steep.....	4,230	.6
Amtoft-Rock outcrop complex, 30 to 60 percent slopes, eroded.....	14,230	2.1	Deer Creek stony silt loam, 6 to 30 percent slopes.....	6,435	1.0
Anco silty clay loam.....	5,740	.9	Deer Creek stony silt loam, high rainfall, 6 to 25 percent slopes.....	11,445	1.7
Ant Flat stony loam, 8 to 25 percent slopes.....	2,380	.4	Deer Creek stony silt loam, high rainfall, 25 to 40 percent slopes.....	5,630	.8
Ant Flat stony loam, 25 to 40 percent slopes, eroded.....	1,470	.2	Deer Creek-Mower complex, 25 to 50 percent slopes.....	3,445	.5
Ant Flat loam, low rainfall, 4 to 8 percent slopes.....	2,485	.4	Denmark gravelly loam, 2 to 5 percent slopes.....	1,990	.3
Ant Flat-Borvant complex, 4 to 25 percent slopes.....	1,080	.2	Donnardo cobbly loam, 4 to 16 percent slopes.....	1,050	.2
Arapien fine sandy loam, 1 to 2 percent slopes.....	3,685	.5	Donnardo very stony loam, 4 to 16 percent slopes.....	3,280	.5
Arapien fine sandy loam, 2 to 5 percent slopes, eroded.....	5,140	.8	Donnardo bouldery loam, 4 to 16 percent slopes.....	530	.1
Arapien fine sandy loam, 5 to 10 percent slopes, eroded.....	215	.1	Doyce loam, 2 to 4 percent slopes.....	1,880	.3
Arapien fine sandy loam, saline-alkali, 1 to 2 percent slopes.....	715	.1	Doyce loam, 4 to 8 percent slopes.....	2,845	.4
Arapien fine sandy loam, wet, 1 to 2 percent slopes.....	1,515	.2	Doyce loam, wet, 2 to 4 percent slopes.....	245	.1
Arapien clay loam, gravelly subsoil, 2 to 5 percent slopes, eroded.....	1,165	.2	Dyreg silty clay.....	4,065	.6
Arapien-Calita complex, 2 to 15 percent slopes.....	2,620	.4	Dyreg silty clay, strongly saline.....	625	.1
Atepic shaly clay loam, 10 to 30 percent slopes, eroded.....	5,000	.7	Ephraim silty clay loam.....	3,040	.5
Atepic very cobbly silty clay loam, 8 to 40 percent slopes.....	4,240	.6	Fluvaquents.....	4,575	.7
Atepic clay loam, red variant-Rock outcrop complex, 30 to 50 percent slopes.....	1,095	.2	Fontreen cobbly loam, 4 to 20 percent slopes.....	7,300	1.1
Atepic-Badland association.....	30,730	4.6	Fontreen very cobbly loam, 20 to 40 percent slopes, eroded.....	11,010	1.6
Badland.....	6,610	1.0	Fontreen very cobbly loam, 40 to 70 percent slopes, eroded.....	10,085	1.5
Bagard very stony clay loam, 10 to 40 percent slopes.....	6,470	1.0	Fontreen-Borvant complex, 4 to 25 percent slopes, eroded.....	4,555	.7
Bagard-Sanpitch complex, 8 to 40 percent slopes.....	13,480	2.0	Freedom-Amtoft complex, 2 to 30 percent slopes.....	2,950	.4
Beek silty clay loam.....	2,000	.3	Genola loam, 0 to 2 percent slopes.....	9,345	1.5
Bezzant cobbly loam, 4 to 25 percent slopes.....	520	.1	Genola loam, 2 to 5 percent slopes, eroded.....	4,855	.7
Bezzant stony loam, 25 to 40 percent slopes.....	2,720	.4	Genola loam, 5 to 10 percent slopes, eroded.....	425	.1
Bezzant-Gappmayer-Rock land association, very steep.....	7,600	1.2	Genola loam, alkali, 0 to 2 percent slopes.....	500	.1
Billings silty clay loam.....	385	.1	Gothic stony loam, 25 to 40 percent slopes, eroded.....	460	.1
Birdow very fine sandy loam, 2 to 4 percent slopes.....	4,960	.8	Green River loam.....	1,910	.3
Birdow very fine sandy loam, 4 to 8 percent slopes.....	1,680	.2	Gullied land.....	450	.1
Birdow silt loam, 2 to 4 percent slopes.....	180	.1	Harding silt loam.....	2,210	.3
Borvant cobbly loam, 8 to 25 percent slopes, eroded.....	5,810	.9	Harkers silt loam, 6 to 25 percent slopes.....	2,115	.3
Borvant-Bagard complex, 10 to 40 percent slopes, eroded.....	5,830	.9	Harkers stony silt loam, 25 to 40 percent slopes.....	2,295	.3
Borvant-Doyce complex, 2 to 10 percent slopes.....	7,320	1.1	Keigley silty clay loam, 2 to 4 percent slopes.....	5,015	.7
Borvant-Lodar complex, 8 to 25 percent slopes, eroded.....	17,625	2.7	Kitchell gravelly loam, 40 to 70 percent slopes.....	4,815	.7
Bradshaw very stony loam, 60 to 80 percent slopes.....	1,070	.2	Kitchell-Mower association.....	1,930	.3
Calita loam, 2 to 4 percent slopes.....	700	.1	Kjar peaty silt loam.....	2,905	.4
Calita loam, 4 to 8 percent slopes.....	525	.1	Linoyer very fine sandy loam, 1 to 2 percent slopes.....	2,780	.4
Canburn silty clay loam.....	1,900	.3	Linoyer very fine sandy loam, 2 to 5 percent slopes, eroded.....	5,720	.8
Centerfield silty clay loam, 1 to 2 percent slopes.....	790	.1	Lisade loam, 1 to 2 percent slopes.....	455	.1
Centerfield silty clay loam, 2 to 5 percent slopes, eroded.....	595	.1	Lisade loam, 2 to 5 percent slopes, eroded.....	3,985	.6
Cheadle very flaggy silt loam, 40 to 70 percent slopes.....	750	.1	Lisade-Sanpete complex, 2 to 5 percent slopes, eroded.....	3,325	.5
Chipman silty clay loam.....	3,050	.5	Lizzant very cobbly loam, 20 to 40 percent slopes.....	6,000	.9
Chipman complex.....	560	.1	Lizzant stony loam, 4 to 20 percent slopes.....	1,570	.2
Clegg loam, 3 to 10 percent slopes.....	2,260	.3	Lizzant very stony loam, 40 to 60 percent slopes.....	10,565	1.6
Collard gravelly sandy loam, 4 to 8 percent slopes.....	2,110	.3	Lizzant-Clegg complex, 3 to 40 percent slopes.....	1,750	.3
			Lizzant-Mower complex, 25 to 60 percent slopes.....	2,070	.3
			Lizzant-Sedwell complex, 5 to 40 percent slopes.....	7,485	1.1
			Lizzant-Kitchell association, steep.....	5,705	.8
			Lodar very channery loam, 8 to 40 percent slopes.....	4,245	.6

TABLE 1.—Approximate acreage and proportionate extent of soils—Continued

Soil	Acres	Percent	Soil	Acres	Percent
Lodar-Fontreen complex, 40 to 70 percent slopes	16,700	2.5	Sanpete gravelly fine sandy loam, 2 to 5 percent slopes	3,870	.6
Lodar-Rock outcrop complex, 8 to 40 percent slopes	1,590	.2	Sanpete cobbly fine sandy loam, 5 to 10 percent slopes, eroded	5,800	.8
Lodar-Rock outcrop complex, 40 to 70 percent slopes	2,700	.4	Sanpete stony fine sandy loam, 5 to 30 percent slopes, eroded	26,055	3.9
Lundy channery silt loam, 5 to 40 percent slopes	310	trace	Sanpitch very stony loam, 8 to 40 percent slopes	1,895	.3
Manassa-Mellor complex	5,900	.9	Sanpitch-Obrast complex, 8 to 40 percent slopes	1,375	.2
Manila loam, 3 to 10 percent slopes	4,735	.7	Sanpitch loam, red variant, 10 to 30 percent slopes	910	.1
Mayfield shaly loam, 2 to 5 percent slopes	345	.1	Shaly colluvial land	3,800	.6
Mayfield shaly loam, 2 to 5 percent slopes, eroded	625	.1	Shumway silty clay loam	4,280	.6
Mellor silt loam	2,460	.4	Shumway silty clay loam, drained	1,015	.2
Mellor silt loam, leached surface	700	.1	Sigurd cobbly fine sandy loam, 5 to 10 percent slopes, eroded	3,830	.6
Moroni silty clay, 2 to 8 percent slopes	2,660	.4	Sigurd gravelly loam, 1 to 5 percent slopes	4,155	.6
Moroni-Atepic complex, 2 to 30 percent slopes	3,965	.6	Skumpah silt loam, 1 to 2 percent slopes	1,500	.2
Mortenson silt loam, 40 to 70 percent slopes	1,800	.3	Skumpah silt loam, 2 to 5 percent slopes, eroded	1,525	.2
Mortenson-Skylick association, very steep	4,170	.6	Skylick silt loam, 4 to 30 percent slopes	900	.1
Mortenson fine sandy loam, thin solum variant, 8 to 30 percent slopes	605	.1	Skylick silt loam, 30 to 70 percent slopes	3,435	.5
Mountainville very stony sandy loam, 2 to 8 percent slopes	1,000	.2	Snake Hollow gravelly fine sandy loam, 2 to 4 percent slopes	555	.1
Mountainville very stony loam, cool, 3 to 10 percent slopes	750	.1	Tingey-Rock outcrop complex, 40 to 70 percent slopes	3,175	.5
Mountainville-Doyce complex, 2 to 8 percent slopes	7,270	1.1	Tingey-Rock outcrop complex, 70 to 80 percent slopes	900	.1
Mountainville cobbly fine sandy loam, hardpan variant, 4 to 20 percent slopes	815	.1	Toehead silt loam, 2 to 4 percent slopes	3,080	.5
Mower clay loam, 5 to 30 percent slopes	1,450	.2	Toehead silt loam, 4 to 8 percent slopes	910	.1
Mower stony clay loam, 5 to 30 percent slopes	835	.1	Toehead silt loam, thin surface variant, 4 to 20 percent slopes	1,565	.2
Mower very stony loam, 25 to 50 percent slopes, eroded	860	.1	Torrifluvents and Torriorthents, stony	2,965	.4
Mower-Lundy complex, 5 to 40 percent slopes	10,330	1.5	Toze gravelly loam, 4 to 25 percent slopes	1,515	.2
Obrast clay loam, low rainfall, 2 to 8 percent slopes	1,360	.2	Wales loam, 2 to 8 percent slopes	4,230	.6
Obrast silty clay, 4 to 25 percent slopes	6,870	1.0	Wales silty clay loam, low rainfall, 0 to 2 percent slopes	1,185	.2
Obrast silty clay, shale substratum, 8 to 25 percent slopes	565	.1	Wales silty clay loam, low rainfall, 2 to 5 percent slopes	615	.1
Pavant loam, 4 to 8 percent slopes	940	.1	Wallsburg very stony loam, 20 to 40 percent slopes	990	.1
Pavant-Doyce complex, 2 to 8 percent slopes	4,745	.7	Wallsburg-Rock outcrop complex, 40 to 70 percent slopes	1,755	.3
Peteetneet peat	1,430	.2	Watkins Ridge stony loam, high rainfall, 4 to 25 percent slopes	805	.1
Poganeab silt loam	5,090	.8	Watkins Ridge silt loam, 1 to 6 percent slopes	1,430	.2
Poganeab silt loam, strongly saline-alkali	1,490	.2	Woodrow silty clay loam, 0 to 2 percent slopes	10,820	1.6
Poganeab silt loam, high lime variant	900	.1	Woodrow silty clay loam, 2 to 5 percent slopes, eroded	4,090	.6
Pritchett stony fine sandy loam, 30 to 70 percent slopes	415	.1	Xerofluvents and Fluvaquents	9,450	1.4
Pritchett silt loam, 20 to 40 percent slopes	1,515	.2	Xerofluvents and Fluvaquents, saline	3,830	.6
Quaker silty clay loam, 1 to 2 percent slopes	3,710	.6	Yeates Hollow stony silt loam, 20 to 40 percent slopes	11,120	1.6
Quaker silty clay loam, 2 to 5 percent slopes	7,720	1.1	Zeesix stony silt loam, 8 to 40 percent slopes	900	.1
Quaker and Mellor soils	2,830	.4	Zeesix-Toze complex, 4 to 40 percent slopes	2,710	.4
Rapho gravelly fine sandy loam, 2 to 5 percent slopes	2,940	.4	Lakes, ponds, reservoirs, and gravel pits	3,679	.5
Rapho gravelly fine sandy loam, 5 to 10 percent slopes	370	.1			
Ravola loam, 1 to 2 percent slopes	365	.1			
Ravola loam, 2 to 5 percent slopes	380	.1			
Ravola loam, 2 to 5 percent slopes, eroded	445	.1			
Rock land	24,835	3.7			
			Total	673,994	100.0

O1—4 inches to 0, gray (10YR 5/1) root mat and silt loam, very dark gray (10YR 3/1) when moist; massive; slightly hard, very friable; mainly very fine and fine grass roots; strongly calcareous; moderately alkaline (pH 8.0); clear, smooth boundary.

A1—0 to 3 inches, light brownish-gray (2.5Y 6/2) silty clay loam, grayish brown (2.5Y 5/2) when moist; massive; hard, firm, slightly sticky and plastic; many fine and very fine and few medium roots; strongly

calcareous; moderately alkaline (pH 8.0); clear, smooth boundary.

C1—3 to 13 inches, light-gray (2.5Y 7/1) heavy silty clay loam, gray (5Y 6/1) when moist; massive; very hard, very firm, sticky and very plastic; many very fine and fine roots; strongly calcareous; moderately alkaline (pH 8.0); clear, smooth boundary.

C2—13 to 39 inches, white (N 8/0) clay, light gray (5Y 7/1) when moist; massive; extremely hard, extremely

firm, very sticky and very plastic; few very fine roots; strongly calcareous; very strongly alkaline (pH 9.1); gradual, wavy boundary.

- C3—39 to 60 inches, white (2.5Y 8/1) silty clay, light gray (5Y 7/1) when moist; massive; extremely hard, very firm, very sticky and very plastic; few very fine roots; strongly calcareous; very strongly alkaline (pH 9.1).

Abcal soils are mottled or have chroma of 1 within a depth of 20 inches. Salinity ranges from slight to strong. The O1 horizon ranges from 0 to 5 inches in thickness.

The A1 horizon is 3 to 11 inches thick. It is gray, light brownish gray, or light gray when dry and ranges from very dark gray or very dark grayish brown to grayish brown or light brownish gray when moist. It is mainly silty clay loam but ranges to silt loam or silty clay.

The C horizon is light brownish gray to light gray or white when dry and gray or grayish brown to light gray when moist. Fine stratification of loam, clay loam, silty clay, or clay is common below a depth of 40 inches.

Aa—Abcal silty clay loam. This soil is on flood plains or alluvial fans. It has the profile described as representative of the series. It is slightly to moderately affected by salts and alkali. Slope is 0 to 2 percent. Runoff is slow, and the hazard of erosion is slight. The available water capacity is 8 to 12 inches.

Included with this soil in mapping are small areas of Shumway silty clay loam, Cache silty clay, Dyreng silty clay, and Abcal silty clay loam, strongly saline.

This soil is used for wet meadow pasture or hay. Capability unit Vw-2 nonirrigated; Wet Meadows range site.

Ab—Abcal silty clay loam, strongly saline. This soil is on flood plains or coalescing alluvial fans. It has a profile similar to the one described as representative of the series, but it is strongly affected by salts and alkali above a depth of 20 inches. Slope is 0 to 2 percent. Runoff is slow, and the hazard of erosion is slight. The available water capacity is 1 to 2 inches. The high salt content reduces the water available to plants.

Included with this soil in mapping are small areas of Abcal silty clay loam, Cache silty clay, and Shumway silty clay loam.

This soil is used for native grass pasture. Capability unit VIIw-28 nonirrigated; Salt Meadows range site.

Ac—Abcal-Cache complex. This mapping unit is on valley bottoms. It is about 50 percent Abcal silty clay loam, strongly saline, and 30 percent Cache silty clay.

The Abcal soil has a profile similar to the one described as representative of the series, but it is strongly affected by salts and alkali above a depth of 20 inches. The high salt content reduces the amount of water available to plants. The available water capacity is 1 to 2 inches.

The Cache soil has the profile described as representative of the Cache series. This nearly level soil is in slightly higher areas of the landscape, which appear white because of the large amount of salts on the surface. The high salt content reduces the water available to plants to 1 to 3 inches.

The hazard of erosion is slight on both soils, and runoff is slow. Included in mapping in the lowest, wettest parts are areas of Abcal silty clay loam and small areas of Shumway silty clay loam. The included Abcal soil makes up about 20 percent of most areas.

This mapping unit is used for native grass pasture. Capability unit VIIw-28 nonirrigated; Salt Meadows range site.

Adel Series

The Adel series consists of well-drained soils that formed in colluvium derived from sandstone and limestone on mountainsides. These soils are commonly associated with Cheadle, Daybell, and Flygare soils. Slopes range from 40 to 80 percent.

Elevation ranges from 8,000 to 9,200 feet. The average annual precipitation is 25 to 30 inches, and the mean annual air temperature is 43° to 45° F. The frost-free period ranges from 80 to 90 days. The native vegetation is brome grass, brackenfern, western cone-flower, and aspen.

In a representative profile the soil is brown silt loam to a depth of 60 inches or more.

Adel soils are typically medium acid to neutral. Permeability is moderate. The available water capacity is 8 to 12 inches, and the annual water-supplying capacity is 15 to 20 inches. Roots can penetrate to a depth of 5 feet or more.

These soils are summer range for livestock, deer, and elk and nesting areas for some species of grouse. They are also important watershed catchment areas.

Representative profile of Adel silt loam, 40 to 80 percent slopes, in a range area on Loafer Mountain, $\frac{3}{4}$ mile south of the radar reflector towers along the jeep road; about 1,155 feet south and 330 feet east of the northwest corner of sec. 34, T. 9 S., R. 3 E., Utah County:

A11—0 to 3 inches, dark-brown (10YR 4/3) silt loam; very dark grayish brown (10YR 3/2) when moist; weak, thin, platy structure; soft, friable, nonsticky and slightly plastic; common fine roots; common fine pores; 10 percent gravel; slightly acid (pH 6.3); abrupt, smooth boundary.

A12—3 to 9 inches, brown (10YR 5/3) silt loam, dark brown (10YR 3/3) when moist; weak, medium, sub-angular blocky structure; slightly hard, friable, slightly sticky and plastic; common very fine roots; few fine and very fine pores; 10 percent gravel; slightly acid (pH 6.4); gradual, smooth boundary.

A13—9 to 23 inches, brown (10YR 5/3) silt loam, dark brown (10YR 3/3) when moist; weak, medium, sub-angular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; few fine and very fine pores; slightly acid (pH 6.4); gradual, smooth boundary.

A14—23 to 45 inches, brown (10YR 5/3) silt loam, dark brown (10YR 3/3) when moist; weak, medium, sub-angular blocky structure; slightly hard, friable, slightly sticky and plastic; common very fine roots; few fine and very fine pores; 20 percent gravel; slightly acid (pH 6.4); gradual, smooth boundary.

A15—45 to 60 inches, brown (10YR 5/3) silt loam, dark brown (10YR 3/3) when moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine and very fine roots; few very fine pores; 20 percent gravel; slightly acid (pH 6.1).

The A horizon is silt loam, loam, or light silty clay loam between depths of 10 and 40 inches. It ranges from 0 to 30 percent gravel, but it averages less than 20 percent and increases, in places, to 40 percent below a depth of 40 inches. The A1 horizon is dark brown or very dark grayish brown to brown when dry and very dark brown to dark brown or very dark grayish brown when moist. It is 16 to 60 inches thick.

The C horizon is brown or grayish brown to light brown or light brownish gray when dry and dark brown or dark grayish brown to brown when moist.

ADG—Adel silt loam, 40 to 80 percent slopes. This soil is on mountainsides. Runoff is medium, and the

hazard of erosion is high. In places this soil is slightly calcareous below a depth of about 40 inches. It has a few deep gullies, and in places it has rills and sheet erosion is active.

Included with this soil in mapping are small areas of Cheadle very flaggy silt loam, 40 to 70 percent slopes, and Daybell gravelly silt loam, 40 to 70 percent slopes.

This soil is used as summer range by sheep, cattle, deer, and elk, and as a nesting area by some species of grouse. It is also an important watershed catchment area and has esthetic value. Capability unit VIIe-H nonirrigated; High Mountain Loam range site.

Amtoft Series

The Amtoft series consists of somewhat excessively drained soils that are 10 to 20 inches deep over limestone. These soils formed in colluvium, local alluvium, and residuum derived from limestone, on hillsides and ridges. Amtoft soils are most commonly associated with Sanpete, Sigurd, Quaker, Woodrow, and Arapien soils. Slopes are 8 to 60 percent.

Elevation ranges from 5,200 to 6,200 feet. The average annual precipitation ranges from 8 to 12 inches, and the mean annual air temperature ranges from 45° to 48° F. The frost-free period ranges from 100 to 130 days. Vegetation is dominantly shadscale, juniper, and annual and perennial grasses.

In a representative profile the surface layer is pale-brown flaggy loam about 8 inches thick. The substratum is very pale brown flaggy and very flaggy loam about 9 inches thick. Fractured limestone bedrock is at a depth of about 17 inches.

The surface layer is strongly calcareous, and the substratum is very strongly calcareous. Reaction is moderately alkaline to strongly alkaline throughout. Permeability is moderately rapid. The effective root zone is limited by bedrock at a depth of 10 to 20 inches. Available water capacity is 0.5 to 2 inches, and the water-supplying capacity is 3 to 6 inches annually.

Amtoft soils are used as range.

Representative profile of Amtoft flaggy loam, 8 to 30 percent slopes, in a range area 1,500 feet east, 1,600 feet north of the southwest corner of sec. 6, T. 18 S., R. 3 E., $\frac{1}{4}$ mile northeast of the Manti Temple, Sanpete County:

A11—0 to 2 inches, light brownish-gray (10YR 6/2) flaggy loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and few fine roots; many fine vesicular pores; 25 percent channery and flaggy coarse fragments, mainly on the surface; strongly calcareous; moderately alkaline (pH 8.4); abrupt, smooth boundary.

A12—2 to 8 inches, pale-brown (10YR 6/3) flaggy loam, dark brown (10YR 4/3) when moist; weak, medium, subangular blocky structure; slightly hard, firm, slightly sticky and plastic; common very fine, few fine and medium roots; few fine and medium pores; 25 percent flaggy and channery coarse fragments; strongly calcareous, lime is in fine rounded masses; moderately alkaline (pH 8.4); clear, wavy boundary.

Clca—8 to 12 inches, very pale brown (10YR 8/3) flaggy loam, pale brown (10YR 6/3) when moist; massive; slightly hard, friable, slightly sticky and plastic; common very fine, few fine and medium roots; few fine and very fine pores; 25 percent flaggy rock fragments;

very strongly calcareous, lime is segregated on the bottom of the coarse fragments and in fine veins and flakes; strongly alkaline (pH 8.8); clear, smooth boundary.

C2ca—12 to 17 inches, very pale brown (10YR 8/3) very flaggy loam, pale brown (10YR 6/3) when moist; massive; soft, friable, slightly sticky and slightly plastic; few very fine roots; few very fine pores; 80 percent flaggy rock fragments that have $\frac{1}{8}$ inch thick lime coating on the bottom; very strongly calcareous, lime is segregated on coarse fragments and in fine veins in flakes and soft rounded masses; strongly alkaline (pH 8.8); abrupt, smooth boundary.

R—17 inches, fractured limestone.

Depth to bedrock ranges from 10 to 20 inches. The A and C horizons are flaggy loam, very flaggy loam, channery loam, very channery loam, gravelly or very gravelly loam, and stony or very stony loam. Content of rock fragments ranges from 25 to 80 percent, but averages more than 35 percent and the fragments are generally less than 15 inches in diameter. Reaction ranges from moderately alkaline to strongly alkaline.

The A horizon is 5 to 9 inches thick. It is grayish brown to pale brown or light brownish gray when dry and very dark grayish brown, dark brown, or grayish brown when moist. Where the A11 horizon is very dark grayish brown when moist and grayish brown when dry, it is 4 inches or less thick.

The Cca horizon is light brownish gray, very pale brown, pale brown, or white when dry and dark grayish brown, pale brown, brown, very pale brown, grayish brown, or light gray when moist.

AEE—Amtoft flaggy loam, 8 to 30 percent slopes. This soil is on hillsides and ridges. It has the profile described as representative of the series. Runoff is medium, and the hazard of erosion is moderate. Moderate sheet and rill erosion are common in places. Included with this soil in mapping are small areas of Lodar very channery loam, 8 to 40 percent slopes; Amtoft-Rock outcrop complex, 30 to 60 percent slopes, eroded; and Atepic shaly clay loam, 10 to 30 percent slopes, eroded.

This soil is used as range. Capability unit VIIs-S nonirrigated; Semi-desert Shallow Loam range site.

AFG2—Amtoft-Rock outcrop complex, 30 to 60 percent slopes, eroded. This mapping unit is on foothills. It is about 85 percent Amtoft very stony loam, 30 to 60 percent slopes, eroded, and about 15 percent Rock outcrop. The Amtoft soil is on the less steep slopes. The Rock outcrop is on the ridges and steepest slopes. The Amtoft soil has a profile similar to the one described as representative of the series, but about 10 percent of the surface is covered with stones.

Runoff is rapid, and the hazard of erosion is severe. There are a few gullies; sheet and rill erosion are common.

Included with this complex in mapping are small areas of Amtoft flaggy loam, 8 to 30 percent slopes, and a soil that is more than 20 inches deep over bedrock.

This mapping unit is used as range. Capability unit VIIs-S nonirrigated; Semi-desert Shallow Loam range site.

Anco Series

The Anco series consists of somewhat poorly drained soils that formed in alluvium derived from limestone, shale, and sandstone on the lower part of alluvial fans and on flood plains. Anco soils are most commonly

associated with Poganeab, Shumway, Abcal, and Kjar soils. Slopes are typically smooth and are 0 to 2 percent.

Elevation ranges from 5,100 to 5,700 feet. The average annual precipitation ranges from 8 to 12 inches, and the mean annual air temperature ranges from 45° to 52° F. The frost-free period ranges from 110 to 130 days. Vegetation in the noncultivated areas is mainly greasewood, saltgrass, and annual weeds.

In a representative profile the surface layer is pale-brown silty clay loam about 9 inches thick. The substratum is mainly light-gray silty clay loam to a depth of about 38 inches and light-gray stratified silt loam and very fine sandy loam to a depth of about 60 inches.

The Anco soils are strongly calcareous throughout. Permeability is moderately slow. The effective root zone is 5 feet or more. The seasonal water table fluctuates between depths of 30 and 60 inches or more. Available water capacity is 8 to 12 inches.

Anco soils are used for irrigated pasture, small grain, and alfalfa. They are also used as habitat by upland game birds.

Representative profile of Anco silty clay loam, in a cultivated field, 1,815 feet north and 400 feet east of the southwest corner of sec. 31, T. 17 S., R. 3 E., about 1 mile north of Manti, Sanpete County:

Ap1—0 to 2 inches, light brownish-gray (10YR 6/2) silty clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, platy structure; hard, firm, sticky and plastic; many fine and very fine roots; few very fine pores; strongly calcareous; moderately alkaline (pH 8.2); abrupt, smooth boundary.

Ap2—2 to 9 inches, pale-brown (10YR 6/3) silty clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium and fine, angular blocky structure; hard, firm, sticky and plastic; common fine and very fine and few coarse roots; few fine and very fine pores; strongly calcareous; moderately alkaline (pH 8.2); clear, smooth boundary.

C1—9 to 16 inches, light brownish-gray (10YR 6/2) silty clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, prismatic structure; very hard, very firm, very sticky and plastic; few fine, very fine, and medium roots; common, very fine and fine pores; strongly calcareous; moderately alkaline (pH 8.4); gradual, wavy boundary.

C2—16 to 25 inches, light-gray (10YR 7/2) silty clay loam, grayish brown (10YR 5/2) when moist; weak, medium, prismatic structure; very hard, very firm, very sticky and plastic; few, medium, fine and very fine roots; common very fine pores; strongly calcareous; moderately alkaline (pH 8.4); gradual, wavy boundary.

C3—25 to 33 inches, light-gray (10YR 7/2) silty clay loam, grayish brown (10YR 5/2) when moist; few, fine, distinct, gray (5Y 5/1) and few, medium, distinct, dark-brown (7.5YR 4/4) mottles; weak, fine, prismatic structure parting to weak, medium, subangular blocky; very hard, firm, sticky and plastic; few fine and very fine roots; common very fine and few fine pores; strongly calcareous; strongly alkaline (pH 8.8); clear, smooth boundary.

C4—33 to 38 inches, light-gray (10YR 7/2) silty clay loam, grayish brown (10YR 5/2) when moist; few, medium, distinct, gray (5Y 5/1) and few, medium, distinct, yellowish-brown (10YR 5/4) mottles; massive; hard, firm, sticky and plastic; few very fine roots; common very fine pores; strongly calcareous; strongly alkaline (pH 8.8); clear, smooth boundary.

C5—38 to 46 inches, light-gray (10YR 7/2) silt loam, grayish brown (10YR 5/2) when moist; common, medium, distinct, yellowish-brown (10YR 5/4) mottles; massive; hard, friable, slightly sticky and plastic; few fine and very fine roots; few fine and common very fine

pores; strongly calcareous; strongly alkaline (pH 8.8); clear, smooth boundary.

C6—46 to 62 inches, light-gray (10YR 7/2) very fine sandy loam, grayish brown (10YR 5/2) when moist; common, medium, distinct, yellowish-brown (10YR 5/4) mottles; massive; hard, friable, slightly sticky and slightly plastic; strongly calcareous; very strongly alkaline (pH 9.1).

Depth to mottling is 20 to 40 inches. Texture between depths of 10 and 40 inches is generally silty clay loam, but individual strata range from silty clay to silt loam.

The A horizon is 9 to 12 inches thick. It is grayish brown to light brownish gray or pale brown when dry and is very dark grayish brown to brown when moist. Where the upper part of the A horizon is grayish brown when dry and very dark grayish brown when moist, it is 4 inches or less thick. Reaction is moderately alkaline to strongly alkaline.

The C horizon is grayish brown or light brownish gray to light gray when dry and dark grayish brown to grayish brown when moist. Reaction ranges from moderately alkaline to strongly alkaline above a depth of 40 inches. Below a depth of 40 inches the C horizon ranges from silty clay to loamy sand and from strongly alkaline to very strongly alkaline.

Ag—Anco silty clay loam. This soil is on alluvial fans and flood plains. Slope is 0 to 2 percent. Runoff is slow, and the hazard of erosion is slight.

Included with this soil in mapping are small areas of Ephraim silty clay loam; Woodrow silty clay loam, 0 to 2 percent slopes; Shumway silty clay loam; and Abcal silty clay loam.

Most of the acreage of this soil is used for irrigated pasture, small grain, corn for silage, and alfalfa. Capability unit IIIw-2 irrigated; range site not assigned.

Ant Flat Series

The Ant Flat series consists of well-drained soils that formed in alluvium and colluvium derived from sandstone, quartzite, and shale. These soils are on alluvial fans, alluvial plains, and mountainsides. Ant Flat soils are most commonly associated with Deer Creek, Manila, Borvant, and Toehead soils. Slopes range from 4 to 40 percent.

Elevation ranges from 5,600 to 7,500 feet. The average annual precipitation ranges from 14 to 18 inches, and the mean annual air temperature ranges from 38° to 42° F. The frost-free period ranges from 80 to 100 days. Vegetation is big sagebrush, oakbrush, perennial grasses, snowberry, bitterbrush, and serviceberry.

In a representative profile the surface layer is dark-brown loam and silt loam about 12 inches thick. The upper 13 inches of the subsoil is brown silty clay. The lower 21 inches is light-brown silty clay or clay loam. The substratum to a depth of 60 inches or more is pink loam.

The surface layer and upper part of the subsoil are noncalcareous, and the lower part of the subsoil and the substratum are moderately calcareous to strongly calcareous. Permeability is slow. The available water capacity is 8 to 12 inches. The water-supplying capacity of nonirrigated soils is 11 to 13 inches annually. The root zone is 5 feet or more.

These soils are used for nonirrigated alfalfa, wheat, and grass. They are also used as range for livestock, deer, and elk.

Representative profile of Ant Flat loam, low rainfall, 4 to 8 percent slopes, in a cultivated field on the Fountain Green Divide, 500 feet west and 1,320 feet south of the northeast corner of sec. 23, T. 13 S., R. 2 E., Sanpete County:

- Ap—0 to 6 inches, dark-brown (10YR 4/3) loam, dark brown (10YR 3/3) when moist; weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky and plastic; few fine and very fine roots; few fine and medium pores; slightly acid (pH 6.5); clear, smooth boundary.
- A12—6 to 12 inches, dark-brown (10YR 4/3) silt loam, dark brown (10YR 3/3) when moist; weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky and plastic; few very fine roots; common very fine pores; neutral (pH 6.6); clear, smooth boundary.
- B1—12 to 18 inches, brown (10YR 5/3) silty clay loam, dark brown (10YR 3/3) when moist; moderate, medium, angular blocky structure; hard, firm, sticky and plastic; few very fine roots; few medium and fine pores; neutral (pH 6.8); gradual, smooth boundary.
- B2t—18 to 31 inches, brown (7.5YR 5/3) silty clay, dark brown (7.5YR 4/3) when moist; weak, medium, prismatic structure parting to strong angular blocky; very hard, very firm, sticky and very plastic; few very fine roots; few medium and fine pores, common moderately thick clay films; neutral (pH 7.3); gradual, smooth boundary.
- B31ca—31 to 40 inches, light-brown (7.5YR 6/3) silty clay, dark-brown (7.5YR 4/3) when moist; moderate, medium, subangular block structure; very hard, very firm, sticky and very plastic; few very fine roots; few very fine pores; slightly calcareous, lime in veins; moderately alkaline (pH 8.0); clear, smooth boundary.
- B32ca—40 to 52 inches, light-brown (7.5YR 6/3) clay loam, dark brown (7.5YR 4/3) when moist; weak, medium, subangular blocky structure; very hard, firm, sticky and plastic; few very fine pores; moderately calcareous, lime in veins; moderately alkaline (pH 8.2); gradual, smooth boundary.
- Cca—52 to 60 inches, pink (7.5YR 7/4) loam, brown (7.5YR 5/4) when moist; massive; slightly hard, friable, slightly sticky and slightly plastic; strongly calcareous; moderately alkaline.

Depth to shale bedrock is 40 inches or more. The A horizon is dark brown or dark grayish brown to brown or grayish brown when dry and dark brown or very dark grayish brown when moist. It is 7 to 17 inches thick. Reaction ranges from slightly acid to neutral.

The B2t horizon ranges from heavy silty clay loam to clay. It is 8 to 20 inches thick. The B2t horizon ranges from brown to red, reddish brown, light reddish brown, or light brown when dry and from dark brown to dark red, dark reddish brown, brown, or reddish brown when moist. Reaction is slightly acid to mildly alkaline.

AHD—Ant Flat stony loam, 8 to 25 percent slopes. This soil is on alluvial fans and mountainsides. It has a profile similar to the one described as representative of the series, but about 2 percent of the surface is covered by stones or cobbles. Runoff is medium, and the hazard of erosion is moderate. Average annual precipitation ranges from 14 to 18 inches. The water-supplying capacity is 11 to 13 inches annually.

Included with this soil in mapping are small areas of Deer Creek stony silt loam, high rainfall, 6 to 25 percent slopes; Toehead silt loam, 4 to 8 percent slopes; and Mower clay loam, 5 to 30 percent slopes.

This soil is used as spring and fall range by livestock and is used as winter range by deer and elk. Capability unit VIe-M nonirrigated; Mountain Loam range site.

AHE2—Ant Flat stony loam, 25 to 40 percent slopes, eroded. This soil is on mountainsides. It has a profile similar to the one described as representative of the series, but about 2 percent of the surface is covered by stones or cobbles and, in the open spaces between clumps of oakbrush, 2 to 5 inches of the surface layer has been removed. Runoff is medium, and the hazard of erosion is high. There are rills and shallow gullies. Average annual precipitation ranges from 16 to 18 inches. Water-supplying capacity is 11 to 13 inches annually. In places this soil is underlain by red shale below a depth of 40 inches.

Included with this soil in mapping are small areas of Obrast silty clay, 4 to 25 percent slopes, and Deer Creek stony silt loam, high rainfall, 25 to 40 percent slopes.

This soil is used as spring and fall range by livestock and is used as winter range by deer and elk. It is also used as watershed. Capability unit VIe-M nonirrigated; Mountain Loam (Oak) range site.

AkC—Ant Flat loam, low rainfall, 4 to 8 percent slopes. This soil is on alluvial fans. It has the profile described as representative of the series. Runoff is medium, and the hazard of erosion is slight. The average annual precipitation is about 14 inches. The water-supplying capacity of nonirrigated soils is about 11 inches annually.

Included with this soil in mapping are small areas of Borvant cobbly loam, 8 to 25 percent slopes, and Deer Creek stony silt loam, 6 to 30 percent slopes. Also included, in the bottoms of the swales, are areas where the surface layer is 17 to 25 inches thick.

This soil is used for nonirrigated alfalfa, small grain, and grass. It is also used as range. Capability unit IIIe-U nonirrigated; Upland Loam range site.

ALD—Ant Flat-Borvant complex, 4 to 25 percent slopes. This mapping unit is on alluvial fans, alluvial plains, and hillsides. It is about 45 percent Ant Flat loam, low rainfall, 4 to 8 percent slopes; about 40 percent Borvant cobbly loam, 8 to 25 percent slopes, eroded; about 10 percent of a soil similar to Calita loam, 4 to 8 percent slopes; and 5 percent Manila loam, 3 to 18 percent slopes. The Ant Flat soil is chiefly in swales and depressions, and the Borvant soil is on ridges and knolls. Runoff is medium, and the hazard of erosion is slight.

This mapping unit is used for nonirrigated alfalfa, wheat, and grass. Ant Flat soils are well suited to these crops; Borvant soils are not well suited because they are shallow over a hardpan and have cobbles and stones on the surface. The unit is also used for grazing livestock in spring and fall and deer and elk in winter. Capability unit VIIs-U nonirrigated; Ant Flat soil in Upland Loam range site, Borvant soil in Upland Shallow Hardpan (Juniper-Pinon) range site.

Arapien Series

The Arapien series consists of well drained and moderately well drained soils that formed in alluvium derived from shale, limestone, and sandstone on alluvial fans and alluvial plains. Arapien soils are commonly associated with Calita, Lisade, Genola, and Sanpete soils. Slopes are 1 to 15 percent.

Elevation ranges from 5,200 to 6,000 feet. The average annual precipitation ranges from 8 to 14 inches, and the mean annual air temperature ranges from 45° to 49° F. The frost-free period ranges from 115 to 130 days. Vegetation in the noncultivated areas is yellowbrush, winterfat, shadscale, and perennial grasses.

In a representative profile the surface layer is light-brown fine sandy loam about 10 inches thick. The substratum, to a depth of about 38 inches, is mostly pink clay loam and loam. Below this, to a depth of 61 inches, it is light-brown very fine sandy loam and gravelly sandy loam.

The Arapien soils are strongly calcareous in the surface layer and very strongly calcareous in the substratum. In places the soil is saline-alkali affected. Permeability is moderate. The effective root zone is 5 feet or more. The seasonal water table is between depths of 30 and 60 inches in places as a result of the low-lying position of the soils, irrigation ditch seepage, and excessive irrigation on the higher lying adjacent soils.

Arapien soils are used mainly for irrigated alfalfa, small grain, corn for silage, as improved and native pasture, and as range.

Representative profile of Arapien fine sandy loam, 1 to 2 percent slopes, in a range area, 330 feet west and 100 feet south of the center of sec. 21, T. 20 S., R. 1 E., $\frac{3}{4}$ mile east of Axtell on the south side of the road, Sanpete County:

- A11—0 to 2 inches, pinkish-gray (7.5YR 6/2) fine sandy loam, brown (7.5YR 5/3) when moist; weak, thick, platy structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; common fine pores; strongly calcareous; strongly alkaline (pH 8.8); abrupt, smooth boundary.
- A12—2 to 10 inches, light-brown (7.5YR 6/3) fine sandy loam, brown (7.5YR 5/3) when moist; weak, thick, platy structure; slightly hard, friable, slightly sticky and slightly plastic; common fine and very fine roots; few medium and fine pores; strongly calcareous, lime in fine soft rounded masses; strongly alkaline (pH 8.8); clear, wavy boundary.
- C1ca—10 to 13 inches, light-brown (7.5YR 6/4) fine sandy loam, brown (7.5YR 5/4) when moist; weak, thick, platy structure; hard, friable, slightly sticky and plastic; common very fine roots concentrated on top of structure plates; few very fine pores; very strongly calcareous, lime in veins and flakes; strongly alkaline (pH 8.8); clear, smooth boundary.
- C2ca—13 to 30 inches, pink (7.5YR 7/3) clay loam, light brown (7.5YR 6/3) when moist; weak, medium, platy structure that parts to weak, fine, subangular blocky; hard, firm, sticky and plastic; common very fine roots; common fine and very fine pores; very strongly calcareous, lime in soft rounded masses; flakes, and veins; strongly alkaline (pH 8.9); gradual, smooth boundary.
- C3ca—30 to 38 inches, pink (7.5YR 7/4) loam, light brown (7.5YR 6/4) when moist; massive; hard, friable, slightly sticky and slightly plastic; few very fine roots; common very fine pores; very strongly calcareous, lime in fine, soft, rounded masses, veins, and flakes; strongly alkaline (pH 8.9); gradual, smooth boundary.
- C4—38 to 48 inches, light-brown (7.5YR 6/4) very fine sandy loam, brown (7.5YR 5/4) when moist; massive; hard, friable, slightly sticky and plastic; few very fine roots; few medium and fine pores; strongly calcareous, lime in flakes; strongly alkaline (pH 8.9); clear, wavy boundary.
- C5—48 to 61 inches, light-brown (7.5YR 6/4) gravelly sandy loam stratified with thin layers of gravelly loam and clay loam, brown (7.5YR 5/4) when moist; massive;

hard, friable, sticky and slightly plastic; few fine pores; 40 percent gravel; very strongly calcareous, lime in veins and flakes; strongly alkaline (pH 8.9).

The A horizon ranges from loam to fine sandy loam 4 to 13 inches thick. It ranges from light brown to brown, pinkish white, pinkish gray, or pale brown when dry and brown to dark brown or grayish brown when moist. Reaction is moderately alkaline to strongly alkaline.

The C horizon is light brown to pink to very pale brown when dry and brown or light brown to pink or very pale brown or pale brown when moist. The Cca horizon ranges from heavy loam to clay loam. Reaction is moderately alkaline to very strongly alkaline. Below a depth of about 40 inches the C horizon is stratified loam, sandy loam, silt loam, silty clay loam, gravelly sandy loam, or very gravelly loamy sand that contains 0 to 70 percent gravel. The soil ranges from nonsaline to strongly saline.

AmB—Arapien fine sandy loam, 1 to 2 percent slopes. This soil is on coalescing alluvial fans and alluvial plains. It has the profile described as representative of the series. Runoff is slow, and the hazard of erosion is slight. The available water capacity is 8 to 11 inches. The water-supplying capacity of nonirrigated soils is 5 to 8 inches annually. In places gravel content is 10 to 40 percent below a depth of 40 inches.

Included with this soil in mapping are small areas of Arapien fine sandy loam, 2 to 5 percent slopes, eroded; Lisade loam, 1 to 2 percent slopes; and Linoyer very fine sandy loam, 1 to 2 percent slopes.

Most of the acreage of this soil is used for irrigated alfalfa, small grain, corn silage, and as pasture. A few small areas are used as range. Capability units IIe-2 irrigated, VIIe-S nonirrigated; Semi-desert Limy Loam range site.

AmC2—Arapien fine sandy loam, 2 to 5 percent slopes, eroded. This soil is on alluvial fans. It has a profile similar to the one described as representative of the series (fig. 1), but it is moderately eroded. The pinkish underlying material is exposed in places, especially where the soil has been cultivated. In places, gravel content is 15 to 35 percent below a depth of 40 inches. Runoff is medium, and the hazard of erosion is moderate. There are a few deep gullies, and sheet and rill erosion are common. The available water capacity is 8 to 10 inches, and the average annual precipitation is 8 to 12 inches. The water-supplying capacity of nonirrigated soils is 5 to 8 inches annually.

Included with this soil in mapping are small areas of Arapien fine sandy loam, 1 to 2 percent slopes; Lisade loam, 2 to 5 percent slopes, eroded; and Sanpete gravelly fine sandy loam, 2 to 5 percent slopes.

This soil is used for irrigated alfalfa, small grain, corn silage, and pasture. It is also used as range and as habitat by upland game birds. Capability units IIIe-2 irrigated, VIIe-S nonirrigated; Semi-desert Limy Loam range site.

AmD2—Arapien fine sandy loam, 5 to 10 percent slopes, eroded. This soil is on alluvial fans. It has a profile similar to the one described as representative of the series, but it is moderately eroded, and the surface layer is 4 to 10 inches thick. Runoff is rapid, and the hazard of erosion is severe. There are a few deep gullies, and rill erosion is prominent in many places. Sheet erosion is active. In a few places there is 20 to 70 percent gravel below a depth of 40 inches. Average annual precipitation is 8 to 12 inches.



Figure 1.—Arapien fine sandy loam, 2 to 5 percent slopes, eroded. A light colored, limy layer is between depths of 10 and 38 inches.

Available water capacity is 8 to 10 inches. The water-supplying capacity of nonirrigated soils is 5 to 8 inches annually.

Included with this soil in mapping are small areas of Arapien fine sandy loam, 2 to 5 percent slopes, eroded, and Arapien clay loam, gravelly subsoil, 2 to 5 percent slopes, eroded.

This soil is used mainly as range, but in a few places it is used for irrigated alfalfa and hay or as pasture. Capability units IVE-2 irrigated, VIIe-S nonirrigated; Semi-desert Limy Loam range site.

AnB—Arapien fine sandy loam, saline-alkali, 1 to 2 percent slopes. This soil is near the lower end of coalescing alluvial fans. It has a profile similar to the one described as representative of the series, but it is strongly saline-alkali affected above a depth of 20 inches. It has a seasonal water table at depths between 30 and 60 inches. The water table is a result of the low-lying position of this soil and excessive loss of water from ditches on higher lying irrigated soils. Mottles may occur below a depth of 40 inches. Runoff is slow, and the hazard of erosion is slight. The average annual precipitation is 8 to 12 inches, and the available water capacity is 1 to 2 inches. The water available to plants is greatly reduced by the high salt content.

Included with this soil in mapping are small areas of Arapien fine sandy loam, wet, 1 to 2 percent slopes; Arapien fine sandy loam, 1 to 2 percent slopes; and Quaker and Mellor soils.

This soil is used as range. Vegetation is mainly greasewood and big rabbitbrush. Capability unit VIIw-28 nonirrigated; Alkali Bottoms range site.

AoB—Arapien fine sandy loam, wet, 1 to 2 percent slopes. This soil is near the lower end of coalescing alluvial fans. It has a profile similar to the one described as representative of the series, but it has a seasonal water table at depths between 30 and 60 inches. The water table is a result of the low-lying position of this soil, lateral movement of the flood plain water table, and excessive loss of water from ditches and irrigation on higher lying soils. In places mottles are below a depth of 40 inches. Runoff is slow, and the hazard of erosion is slight. The average annual precipitation is 8 to 12 inches, and the available water capacity is 8 to 10 inches.

Included with this soil in mapping are small areas of Arapien fine sandy loam, 1 to 2 percent slopes, and Arapien fine sandy loam, saline-alkali, 1 to 2 percent slopes.

This soil is used as irrigated and native grass pasture. Small areas have been drained and used for irrigated alfalfa and small grain. Capability units IIIw-2 irrigated, VIw-2 nonirrigated; Semi-wet Meadows range site.

ApC2—Arapien clay loam, gravelly subsoil, 2 to 5 percent slopes, eroded. This soil is on alluvial fans. It has a profile similar to the one described as representative of the series, but it is eroded, and gravel content is 20 to 35 percent between depths of 20 and 40 inches. Below a depth of 40 inches gravel content ranges from 35 to 70 percent. This soil is well drained. Runoff is medium, and the hazard of erosion is moderate. Average annual precipitation is 8 to 12 inches. Available water capacity is 5 to 9 inches. The water-supplying capacity of nonirrigated soils is 5 to 7 inches annually. There are a few deep gullies, and rill and sheet erosion are common.

Included with this soil in mapping are small areas of Arapien fine sandy loam, 2 to 5 percent slopes, eroded; Sanpete gravelly fine sandy loam, 2 to 5 percent slopes; and Centerfield silty clay loam, 2 to 5 percent slopes, eroded.

This soil is used for irrigated alfalfa, small grain, and as pasture. It is also used for urban development, as range, and as habitat by upland game birds and small game. Capability units IIIe-2 irrigated, VIIe-S nonirrigated; Semi-desert Limy Loam range site.

ARD—Arapien-Calita complex, 2 to 15 percent slopes. This mapping unit is on the rolling hills. It is about 40 percent Arapien cobbly loam, high rainfall, 4 to 15 percent slopes, on ridges and steepest side slopes; about 40 percent Calita loam, 4 to 8 percent slopes, on gentle side slopes and in lower areas; and about 20 percent Keigley silt loam, 2 to 4 percent slopes, in swales and bottom areas. Also included are small areas of Moroni silty clay, 2 to 8 percent slopes.

Arapien cobbly loam, high rainfall, 4 to 15 percent slopes, has a profile similar to the one described as representative of the series, but the surface layer has

20 percent cobbles and gravel mainly as a mantle on the surface. Runoff is rapid, and the hazard of erosion is severe. There are a few shallow gullies and rills in some places. The average annual precipitation is 12 to 14 inches, and the frost-free period is 115 to 120 days. Available water capacity is 8 to 10 inches. The water-supplying capacity is about 9 inches annually. The soil is well drained. This soil is moderately difficult to till because of the cobbles or gravel on the surface.

Calita loam, 4 to 8 percent slopes, has a profile similar to the one described as representative of the Calita series. Keigley silt loam, 2 to 4 percent slopes, also has a profile similar to the one described as representative of the Keigley series.

This mapping unit is used for nonirrigated wheat and grass and as range. Dominant vegetation is big sagebrush, rubber rabbitbrush, Indian ricegrass, and bluebunch wheatgrass. Capability unit IVE-UZ non-irrigated; Upland Loam range site.

Atepic Series

The Atepic series consists of well-drained soils that are less than 20 inches deep over weathered shale. These soils formed in colluvium and residuum derived from shale on foothills and lower mountainsides. They are most commonly associated with Fontreen, Borvant, Lodar, and Sanpitch soils. Slopes are 8 to 40 percent.

Elevation ranges from 6,000 to 7,200 feet. The average annual precipitation ranges from 12 to 15 inches, and the mean annual air temperature ranges from 45° to 47° F. The frost-free period ranges from 100 to 110 days. Vegetation is juniper, big sagebrush, pinon, Indian ricegrass, and bitterbrush.

In a representative profile the surface layer is light brownish-gray shaly clay loam about 6 inches thick. The substratum is about 11 inches of light brownish-gray or light-gray very strongly calcareous shaly silty clay loam underlain by about 23 inches of pale-olive soft decomposing shale. Hard shale is at a depth of 40 inches.

Reaction is moderately alkaline to strongly alkaline throughout. Permeability is slow. The available water capacity is about 3 inches. The water-supplying capacity is 4 to 6 inches annually. The root zone is limited by the shale, and the roots extend horizontally on the shale and penetrate the fractures in the bedrock.

Atepic soils are used mainly as spring and fall range by livestock and as winter range by deer and elk. They are also used for woodland.

Representative profile of Atepic shaly clay loam, 10 to 30 percent slopes, eroded, in a range area about 3,000 feet north and 400 feet west of the southeast corner of sec. 2, T. 18 S., R. 1 E., near the head of Mellor Canyon, Sanpete County:

A11—0 to 2 inches, light brownish-gray (10YR 6/2) shaly clay loam, grayish brown (10YR 5/2) when moist; weak, medium, platy structure; hard, firm, sticky and plastic; few fine roots; common fine vesicular pores; 25 percent shaly fragments as a surface mantle; very strongly calcareous; moderately alkaline (pH 8.2); abrupt, smooth boundary.

A12—2 to 6 inches, light brownish-gray (10YR 6/2) shaly clay loam, brown (10YR 5/3) when moist; weak,

medium, subangular blocky structure; slightly hard, firm, sticky and plastic; common fine roots; few fine and medium pores; 25 percent shaly fragments; very strongly calcareous; moderately alkaline (pH 8.2); clear, smooth boundary.

C1—6 to 11 inches, light brownish-gray (2.5Y 6/2) shaly silty clay loam, grayish brown (2.5Y 5/2) when moist; moderate, fine, subangular blocky structure; hard, firm, sticky and plastic; few fine and medium roots; few fine and very fine pores; 25 percent shaly fragments; strongly calcareous; strongly alkaline (pH 8.6); clear, smooth boundary.

C2ca—11 to 17 inches, shaly silty clay loam that is 60 percent light gray (5Y 7/2) and 40 percent pale yellow (2.5Y 8/4), 60 percent olive (5Y 5/3) and 40 percent light yellowish brown (2.5Y 6/3) when moist; massive; very hard, firm, sticky and plastic; few fine roots; no pores; very strongly calcareous, lime in fine soft rounded masses; strongly alkaline (pH 8.6); clear, smooth boundary.

C3—17 to 40 inches, pale-olive (5Y 6/3) soft shale, olive gray (5Y 5/3) when moist; massive; very hard, firm, sticky and plastic; few fine and medium roots; no pores; very strongly calcareous, lime coatings on shaly fragments; strongly alkaline (pH 8.6); gradual, smooth boundary.

R—40 to 44 inches, olive-gray (5Y 5/2) hard shale, olive gray (5Y 4/2) when moist; slightly calcareous; strongly alkaline (pH 8.6).

Depth to weathered shale is 10 to 20 inches. The average texture between a depth of 10 inches and shale ranges from shaly silty clay loam to shaly clay loam, and content of shaly fragments, by volume, ranges from 20 to 35 percent.

The A horizon is 4 to 9 inches thick. It is grayish brown or light brownish gray to light yellowish brown when dry and brown or very dark grayish brown to light olive brown when moist. Where the A11 horizon is grayish brown when dry and very dark grayish brown when moist, it is 4 inches or less thick.

The Cca horizon ranges from light gray to grayish brown, very pale brown, or pale yellow when dry and olive to dark grayish brown, light brownish gray, or light yellowish brown when moist.

ASE2—Atepic shaly clay loam, 10 to 30 percent slopes, eroded. This soil is on foothills. It has the profile described as representative of the series. Runoff is rapid, and the hazard of erosion is severe. Sheet erosion is active, and gullies have cut down into the shale. This soil is a high producer of silt by runoff from summer storms or rapid snow melt.

Included with this soil in mapping are small areas of Lodar very channery loam, 8 to 40 percent slopes; Badland; Rock land; Borvant cobbly loam, 8 to 25 percent slopes, eroded; and Mower clay loam, 5 to 30 percent slopes.

This soil is used mainly as spring and fall range by livestock. It is also used as winter range by deer and elk. The juniper and pinon are used for firewood, and the juniper is used for fenceposts. Capability unit VIIs-U nonirrigated; Upland Shallow Shale (Juniper-Pinon) range site.

ATF—Atepic very cobbly silty clay loam, 8 to 40 percent slopes. This soil is on foothills. It has a profile similar to the one described as representative of the series, but the surface layer is 50 percent or more cobbles, mainly as a mantle on the surface. In places, gullies have cut down into the shale. Runoff is rapid, and the hazard of erosion is severe.

Included with this soil in mapping are small areas of Mower very stony loam, 25 to 50 percent slopes, eroded; Atepic shaly clay loam, 10 to 30 percent slopes,

eroded; and Borvant cobbly loam, 8 to 25 percent slopes, eroded.

This soil is used mainly as spring and fall range by sheep and cattle and as winter range by deer and elk. The juniper and pinon grown on this soil are used for firewood, and the juniper is used for fenceposts. Some areas have been chained and seeded to grass. Capability unit VIIs-U nonirrigated; Upland Shallow Shale (Juniper-Pinon) range site.

AV—Atepic-Badland association. This mapping unit is on foothills. It is about 50 percent Atepic shaly clay loam, 10 to 30 percent slopes, eroded; about 40 percent Badland, mainly on the steepest slopes that have a southern exposure; and about 10 percent Fontreen very cobbly loam, 20 to 40 percent slopes, eroded, and Borvant cobbly loam, 8 to 25 percent slopes, eroded. The Fontreen and Borvant soils are moderately steep and have a northern exposure. Rock land is included in many of the Badland areas. Runoff is rapid on the Atepic soils, and the hazard of erosion is severe. The soil is readily dispersed by raindrops, and erosion is active. Sheet and rill erosion are common. Runoff from this mapping unit accelerates gully erosion on the lower slopes. A very high production of silt is a result of runoff from summer storms or from rapid snowmelt.

This mapping unit is better suited to range than to other uses. Atepic soil in capability unit VIIs-U nonirrigated, Upland Shallow Shale (Juniper-Pinon) range site; Badland in capability unit VIIIe-E; range site not assigned.

Atepic Variant

The Atepic variant consists of well-drained soils that are less than 20 inches deep over shale. These soils are similar to the Atepic soils, but they are reddish brown and clayey between depths of 10 inches and the shale bedrock. They formed in colluvium and residuum derived from shale on foothills. The Atepic variant is most commonly associated with Amtoft soils. Slope is 30 to 50 percent.

Elevation ranges from 5,300 to 6,000 feet. The average annual precipitation is 8 to 12 inches, and the mean annual air temperature ranges from 45° to 47° F. The frost-free period is 100 to 110 days. Vegetation is shadscale, yellowbrush, scattered juniper, and Indian ricegrass.

In a representative profile the surface layer is reddish-brown cobbly clay loam about 4 inches thick. The subsoil extends to a depth of 20 inches. The upper 12 inches is reddish-brown gravelly clay. The lower 4 inches is red very gravelly silty clay. Hard red shale is at a depth of 20 inches.

Permeability is slow. The available water capacity is 2 to 3 inches. The water-supplying capacity is less than 4 inches annually. The effective root zone is limited by the shale at depths of 10 to 20 inches.

This soil is used mainly as range.

Representative profile of Atepic cobbly clay loam, red variant, in an area of Atepic clay loam, red variant-Rock outcrop complex, 30 to 50 percent slopes, in a range area about 3 miles southwest of the Gunnison Reservoir, 2,145 feet north and 1,155 feet east of the

southwest corner of sec. 7, T. 19 S., R. 2 E., Sanpete County:

A1—0 to 4 inches, reddish-brown (2.5YR 5/4) cobbly clay loam, dark reddish brown (2.5YR 3/4) when moist; moderate, fine, granular structure; slightly hard, firm, sticky and plastic; few very fine roots; few very fine pores; 20 percent cobbles, mainly a surface mantle; moderately calcareous; moderately alkaline (pH 8.0); clear, smooth boundary.

B21t—4 to 12 inches, reddish-brown (2.5YR 5/4) gravelly clay, dark red (2.5YR 3/4) when moist; moderate, medium, subangular blocky structure; hard, firm, sticky and plastic; few very fine and few fine roots; few very fine pores; 20 percent gravel; common thin clay films on ped faces and pores; moderately calcareous; strongly alkaline (pH 8.7); clear, smooth boundary.

B22tca—12 to 16 inches, reddish-brown (2.5YR 5/4) gravelly clay, dark red (2.5YR 3/6) when moist; strong, fine angular blocky structure; extremely hard, very firm, sticky and plastic; few very fine roots; few very fine pores; 20 percent gravel; common thin clay films on ped faces and in pores; moderately calcareous, lime in thin veins and soft rounded masses; strongly alkaline (pH 8.8); gradual, wavy boundary.

B3tca—16 to 20 inches, red (2.5YR 5/5) very gravelly silty clay, dark red (2.5YR 3/6) when moist; massive; very hard, very firm, sticky and very plastic; few very fine roots; few thin clay films on ped faces and gravel; 50 percent gravel; moderately calcareous, lime in thin veins and soft rounded masses; strongly alkaline (pH 8.6); abrupt, irregular boundary.

R—20 inches, fractured hard red shale.

Depth to shale bedrock is 10 to 20 inches. The A horizon is reddish brown when dry or dark reddish brown when moist. It is 3 to 6 inches thick. The A horizon is moderately calcareous, and reaction is moderately alkaline.

The B2t horizon is reddish brown or dark reddish brown when dry and dark red to red when moist. It ranges from gravelly clay to gravelly silty clay and is 20 to 30 percent gravel. The B2t horizon is slightly calcareous to moderately calcareous, and reaction is moderately alkaline to strongly alkaline.

The C horizon, where present, is very gravelly clay or silty clay that is 50 to 55 percent gravel. It is moderately calcareous to strongly calcareous, and reaction is strongly alkaline to very strongly alkaline.

AUF—Atepic clay loam, red variant-Rock outcrop complex, 30 to 50 percent slopes. This mapping unit is on foothills. It is about 75 percent Atepic cobbly clay loam, red variant, 30 to 40 percent slopes, and 25 percent Rock outcrop. Small areas of Badland are included in mapping. Runoff is rapid, and the hazard of erosion is severe.

This mapping unit is used only as range. Capability unit VIIs-S nonirrigated; Semi-desert Shallow Loam range site.

Badland

BA—Badland consists of nearly bare, strongly sloping to very steep, actively eroding shale hills. The channels of numerous intermittent streams form a branching pattern in most places. Much silt is washed off this land by runoff from summer storms or rapid snowmelt.

Included with Badland in mapping are some hills of interbedded sandstone and shale and some that are sandstone capped. Also included are minor areas of Atepic shaly clay loam, 10 to 30 percent slopes, eroded, and small areas of other shallow soils on northern exposures.

Vegetation is a sparse growth of shadscale, occasional junipers, horsebrush, greasewood, and Mormon tea. paability unit VIIIe-E nonirrigated; range site not assigned.

Bagard Series

The Bagard series consists of well-drained soils that formed in alluvium or colluvium derived from mixed igneous rock, sandstone, and shale on foothills. Bagard soils are most commonly associated with Atepic, Borvant, Obrast, and Sanpitch soils. Slopes are 10 to 40 percent.

Elevation ranges from 6,000 to 7,000 feet. The average annual precipitation ranges from 12 to 14 inches, and the mean annual air temperature ranges from 43° to 45° F. The frost-free period ranges from 90 to 100 days. Vegetation is juniper, pinon, bitterbrush, big sagebrush, perennial grasses, and yellowbrush.

In a representative profile the surface layer is brown very stony and cobbly clay loam about 7 inches thick. The upper part of the subsoil is brown cobbly and very cobbly clay about 17 inches thick. The lower part of the subsoil is light-brown very cobbly clay loam about 14 inches thick. The substratum is pale-brown very cobbly loam and very cobbly sandy clay loam to a depth of about 60 inches.

Permeability is moderately slow. The available water capacity is 4 to 7 inches. The water-supplying capacity is 5 to 9 inches annually. The effective root zone is 5 feet or more.

Bagard soils are used as spring and fall range by sheep or cattle and as winter range by deer and elk. They are also used for woodland.

Representative profile of Bagard very stony clay loam, 10 to 40 percent slopes, in a range area, 300 feet north and 165 feet west of the southeast corner of sec. 3, T. 14 S., R. 3 E., about 3½ miles east of Fountain Green, Sanpete County:

- A11—0 to 2 inches, brown (10YR 4/3) very stony clay loam, dark brown (10YR 3/3) when moist; moderate, fine, granular structure; soft, firm, sticky and plastic; common very fine roots; few interstitial pores; 10 to 25 percent of the surface is covered with stones; neutral (pH 6.8); clear, smooth boundary.
- A12—2 to 7 inches, brown (10YR 4/3) cobbly clay loam, dark brown (10YR 3/3) when moist; weak, medium, subangular blocky structure; hard, firm, sticky and plastic; few very fine and fine roots; few fine pores; 40 percent cobbles and stones; neutral (pH 6.6); gradual, smooth boundary.
- B1—7 to 14 inches, brown (10YR 4/3) cobbly light clay, dark brown (10YR 3/3) when moist; moderate, fine, subangular blocky structure; very hard, very firm, sticky and very plastic; few medium, fine, and very fine roots; few fine pores; few thin clay films; 35 percent cobbles and stones; slightly acid (pH 6.3); gradual, smooth boundary.
- B2t—14 to 24 inches, brown (7.5YR 5/4) very cobbly clay, dark brown (7.5YR 4/3) when moist; strong, medium, angular blocky structure; extremely hard, very firm, sticky and very plastic; few fine roots; few fine pores; many moderately thick clay films; 50 percent cobbles and stones; slightly acid (pH 6.2); gradual, smooth boundary.
- B3—24 to 38 inches, light-brown (7.5YR 6/4) very cobbly clay loam, brown (7.5YR 5/4) when moist; massive; extremely hard, very firm, sticky and very plastic;

few fine and medium roots; few moderately thick clay films; 60 percent cobbles and stones; slightly acid (pH 6.1); gradual, smooth boundary.

C1—38 to 50 inches, pale-brown (10YR 6/3) very cobbly light sandy clay loam, brown (10YR 4/3) when moist; massive; hard, very firm, sticky and plastic; 70 to 80 percent cobbles and stones; slightly calcareous, lime is mainly coatings on rock fragments; neutral (pH 6.6); gradual, smooth boundary.

C2—50 to 60 inches, pale-brown (10YR 6/3) very cobbly loam, brown (10YR 4/3) when moist; massive; slightly hard, friable, slightly sticky and slightly plastic; 70 to 80 percent cobbles and stones; slightly calcareous, lime coatings on rock fragments; neutral (pH 7.0).

The A horizon is 7 to 11 inches thick. It is very dark grayish brown to brown when dry and very dark brown to very dark grayish brown or dark brown when moist. It ranges from very stony or cobbly clay loam to cobbly loam. Reaction is slightly acid to neutral.

The B2t horizon is 8 to 18 inches thick. It is brown or grayish brown to light brown or light yellowish brown when dry and dark brown or dark grayish brown to brown or yellowish brown when moist. It ranges from very cobbly clay, cobbly clay, or stony clay to very stony clay; content of cobbles or stones is 35 to 60 percent. Reaction is slightly acid to mildly alkaline.

The C horizon is pale brown or brown to pink or very pale brown when dry and brown or dark brown to yellowish brown when moist. It ranges from cobbly or very cobbly loam or stony or very stony loam to cobbly or very cobbly clay loam or stony or very stony clay loam. Content of cobbles and stones ranges from 35 to 80 percent. It is noncalcareous to moderately calcareous, and reaction is neutral to moderately alkaline.

BCE—Bagard very stony clay loam, 10 to 40 percent slopes. This soil is on foothills and lower mountainsides. It has the profile described as representative of the series. Runoff is medium, and the hazard of erosion is moderate. In places stones or cobbles cover less than 10 percent of the surface.

Included with this soil in mapping are small areas of Sanpitch very stony loam, 8 to 40 percent slopes; Borvant cobbly loam, 8 to 25 percent slopes, eroded; and Deer Creek stony silt loam, 6 to 30 percent slopes.

This soil is used as spring and fall range by sheep or cattle and as winter range by deer and elk. The juniper is harvested for cedar posts, and both the pinon and juniper are used for firewood. Capability unit VIIIs-U nonirrigated; Upland Stony Loam (Juniper-Pinon) range site.

BDE—Bagard-Sanpitch complex, 8 to 40 percent slopes. This mapping unit is on foothills and lower mountainsides. It is about 45 percent Bagard very stony clay loam, 10 to 40 percent slopes, on northern and eastern exposures; about 35 percent Sanpitch very stony loam, 8 to 40 percent slopes, on southern and western exposures; and about 20 percent Atepic shaly clay loam, 10 to 30 percent slopes, eroded, on eastern, western, and southern exposures mainly in the lower foothill areas. Also included are small areas of Badland and Borvant cobbly loam, 8 to 25 percent slopes, eroded.

The soils in this mapping unit are used as spring and fall range by sheep or cattle and as winter range by deer and elk. The juniper is harvested for cedar posts, and both the juniper and pinon are used for firewood. Capability unit VIIIs-U nonirrigated; Upland Stony Loam (Juniper-Pinon) range site.

Beek Series

The Beek series consists of somewhat poorly drained soils that formed in alluvium derived from limestone and shale on alluvial plains and valley bottoms. Beek soils are most commonly associated with Birdow, Chipman, Canburn, and Keigley soils. Slopes are typically smooth and are 0 to 2 percent.

Elevation ranges from 5,600 to 6,200 feet. The average annual precipitation ranges from 12 to 14 inches, and the mean annual air temperature ranges from 45° to 47° F. The frost-free period ranges from 110 to 125 days. Vegetation in the noncultivated areas is mainly rabbitbrush, grasses, and annual weeds.

In a representative profile the surface layer is dark grayish-brown and grayish-brown silty clay loam about 23 inches thick. The substratum is light brownish-gray and light-gray silty clay loam to a depth of 44 inches and very pale brown loam to a depth of 60 inches.

Beek soils are calcareous throughout. Permeability is moderately slow. The effective root zone is 5 feet or more. The seasonal water table fluctuates between depths of 20 and 60 inches. The available water capacity is 8 to 12 inches.

Beek soils are used for irrigated alfalfa, small grain, and as pasture. They are also used as habitat by wildlife.

Representative profile of Beek silty clay loam, in a cultivated field, 750 feet west and 600 feet north of the southeast corner of sec. 23, T. 14 S., R. 4 E., 2 miles north of Mount Pleasant and 1 mile east of the highway, Sanpete County:

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) when moist; moderate, fine, subangular blocky structure; hard, firm, sticky and plastic; few fine roots; common fine pores; slightly calcareous; moderately alkaline (pH 7.9); clear, smooth boundary.

A12—6 to 18 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) when moist; weak, medium, subangular blocky structure; hard, firm, sticky and plastic; few fine roots; common fine pores; moderately calcareous; moderately alkaline (pH 8.4); gradual, smooth boundary.

A13ca—18 to 23 inches, grayish-brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; few, fine, faint, yellowish-brown (10YR 5/4) mottles; weak, medium, subangular blocky structure; hard, firm, sticky and plastic; few fine roots; few fine and medium pores; very strongly calcareous, lime in soft rounded masses; strongly alkaline (pH 9.0); gradual, smooth boundary.

C1ca—23 to 35 inches, light brownish-gray (10YR 6/2) silty clay loam, dark grayish brown (10YR 4/2) when moist; few, fine, faint, yellowish-brown (10YR 5/4) mottles; massive; hard, firm, sticky and plastic; few fine roots; few fine and medium pores; very strongly calcareous, lime in soft rounded masses and veins; very strongly alkaline (pH 9.2); gradual, smooth boundary.

C2ca—35 to 44 inches, light-gray (10YR 7/1) silty clay loam, grayish brown (2.5Y 5/2) when moist; massive; slightly hard, firm, sticky and plastic; very strongly calcareous, lime in soft rounded masses; very strongly alkaline (pH 9.2); gradual, smooth boundary.

C3—44 to 60 inches, very pale brown (10YR 7/3) loam, light olive brown (2.5Y 5/3) when moist; common, medium, distinct, yellowish-brown (10YR 5/4) mottles; massive; slightly hard, friable, slightly sticky and plastic; strongly calcareous; strongly alkaline (pH 9.0).

The soil is saturated with water for as long as 90 days within a depth of 40 inches where undrained. Texture

between depths of 10 and 40 inches is clay loam or silty clay loam.

The A horizon is 20 to 36 inches thick. It is dark grayish brown or brown to grayish brown when dry and very dark brown to very dark grayish brown or dark brown when moist. Reaction is moderately alkaline to very strongly alkaline.

The C horizon is light brownish gray to light gray when dry and dark grayish brown to grayish brown when moist. It ranges from loam to silty clay loam. Reaction is moderately alkaline to very strongly alkaline.

Be—Beek silty clay loam. This soil is on alluvial fans and valley bottoms. Slope is 0 to 2 percent. Runoff is slow, and the hazard of erosion is slight.

Included with this soil in mapping are small areas of Chipman silty clay loam; Birdow very fine sandy loam, 2 to 4 percent slopes; and Canburn silty clay loam.

Most of this soil is used for irrigated pasture, small grain, and alfalfa. Small areas are used as range. Capability units IIIw-2 irrigated, VIw-2 nonirrigated; Semi-wet Meadows range site.

Bezzant Series

The Bezzant series consists of well-drained soils that formed in alluvium or colluvium derived from sandstone and limestone on mountainsides and alluvial fans. Bezzant soils are most commonly associated with Gappmayer, Bradshaw, Deer Creek, and Harker soils. Slope is 4 to 80 percent.

Elevation ranges from 5,400 to 6,500 feet. The average annual precipitation ranges from 16 to 20 inches, and the mean annual air temperature ranges from 43° to 44° F. The frost-free period ranges from 70 to 90 days. Vegetation is big sagebrush, oakbrush, perennial grasses, and bitterbrush.

In a representative profile the surface layer is dark grayish-brown stony loam and gravelly loam about 11 inches thick. The subsoil is brown gravelly loam about 16 inches thick. The substratum, to a depth of about 47 inches, is light-brown very cobbly loam. Below this, to a depth of 60 inches, it is light-brown very stony sandy loam.

Bezzant soils are calcareous throughout. Permeability is moderate or moderately rapid. The available water capacity is 4 to 7 inches. The water-supplying capacity of nonirrigated soils is 8 to 10 inches annually. The effective root zone is 5 feet or more.

Bezzant soils are used mainly as spring and fall range by sheep or cattle and as winter range by deer and elk. They are also used for irrigated alfalfa or as pasture.

Representative profile of Bezzant stony loam, 25 to 40 percent slopes, in a range area, 2,310 feet north and 165 feet west of the southeast corner of sec. 9, T. 9 S., R. 4 E., on Diamond Fork Road, Utah County:

A11—0 to 4 inches, dark grayish-brown (10YR 4/2) stony loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, platy structure; slightly hard, friable, nonsticky and slightly plastic; few very fine roots; few medium pores; 2 to 10 percent of the surface is covered by cobbles and stones; moderately calcareous; mildly alkaline (pH 7.8); clear, smooth boundary.

A12—4 to 11 inches, dark grayish-brown (7.5YR 3/2) gravelly loam; dark brown (7.5YR 3/2) when moist; weak, fine, subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; few fine and few very fine roots; few fine and few medium pores;

40 percent gravel and cobbles; moderately calcareous; moderately alkaline (pH 8.2); gradual, smooth boundary.

AC—11 to 27 inches, brown (7.5YR 5/4) gravelly loam, dark brown (7.5YR 4/4) when moist; moderate, medium, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine and very fine roots; common fine pores; 25 percent gravel and 20 percent cobbles; moderately calcareous, lime coated on lower sides of gravel; strongly alkaline (pH 8.5); gradual, wavy boundary.

C1ca—27 to 47 inches, light-brown (7.5YR 6/4) very cobbly loam, brown (7.5YR 4/4) when moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few medium and few fine roots; 25 percent gravel and cobbles; strongly calcareous, lime in veins and soft rounded masses; strongly alkaline (pH 8.8); gradual, wavy boundary.

C2—47 to 60 inches, light-brown (7.5YR 6/4) very stony sandy loam, reddish brown (5YR 5/4) when moist; massive; slightly hard, friable, nonsticky and nonplastic; few medium and few fine roots; 25 percent gravel and 30 percent cobbles; strongly calcareous; strongly alkaline (pH 8.6).

Depth to bedrock is 60 inches or more. Texture between depths of 10 and 40 inches is gravelly or very gravelly loam to sandy clay loam, cobbly or very cobbly loam to sandy clay loam, and stony or very stony loam. Rock fragments, mainly cobbles and stones, make up 35 to 80 percent of the volume.

The A horizon is 10 to 12 inches thick. It is dark brown or dark grayish brown to brown or grayish brown when dry and very dark brown or very dark grayish brown to dark brown when moist. The A horizon is slightly calcareous to moderately calcareous, and reaction is neutral to moderately alkaline.

The Cca horizon is 16 to 26 inches thick. It is brown or pink to very pale brown when dry and dark brown to dark grayish brown to brown or grayish brown when moist. Reaction is moderately alkaline to strongly alkaline. The C horizon below a depth of 40 inches ranges from cobbly or very cobbly sandy loam to loamy sand or stony or very stony sandy loam to loamy sand. Content of cobbles, stones, and gravel is 35 to 80 percent.

BFD—Bezzant cobbly loam, 4 to 25 percent slopes. This soil is on foothill slopes and alluvial fans. It has a profile similar to the one described as representative of the series, but the rock fragments in the surface layer and on the surface are cobbles. Runoff is medium, and the hazard of erosion is moderate. Permeability is moderate.

Included with this soil in mapping are small areas of Bezzant stony loam, 25 to 40 percent slopes, and Deer Creek stony silt loam, high rainfall, 6 to 25 percent slopes.

This soil is used mainly as spring and fall range by sheep and cattle. It is also used for irrigated pasture and alfalfa. Capability units IVs-24 irrigated, VIs-U nonirrigated; Upland Stony Loam range site.

BGE—Bezzant stony loam, 25 to 40 percent slopes. This soil is on foothills. It has the profile described as representative of the series. Runoff is medium, and the hazard of erosion is moderate. Permeability is moderate.

Included with this soil in mapping are small areas of Bezzant cobbly loam, 4 to 25 percent slopes, and Deer Creek stony silt loam, high rainfall, 25 to 40 percent slopes.

This soil is used as spring and fall range by sheep or cattle and as winter range by deer and elk. Capability unit VIs-U nonirrigated; Upland Stony Loam range site.

BH—Bezzant-Gappmayer-Rock land association, very steep. This association is on mountainsides. It is about 40 percent Bezzant very stony loam, 60 to 80 percent slopes, mainly on mountainsides; about 35 percent Gappmayer cobbly loam, 60 to 80 percent slopes, in the swales, low places, and on northern exposures; 25 percent Rock land on the points and ridges; small areas of Bradshaw very stony loam, 60 to 80 percent slopes; and small areas of Deer Creek stony silt loam, high rainfall, 25 to 40 percent slopes.

Bezzant very stony loam, 60 to 80 percent slopes, has a profile similar to the one described as representative of the Bezzant series, but 10 to 25 percent of the surface is covered by angular stones, and below a depth of 20 inches the soil is 60 to 80 percent angular rock fragments. Permeability of this Bezzant soil is moderately rapid. Runoff is rapid, and the hazard of erosion is severe.

Gappmayer cobbly loam, 60 to 80 percent slopes, has the profile described as representative of the Gappmayer series. Runoff is medium, and the hazard of erosion is moderate.

These soils are used as winter range by deer, as habitat by upland game birds such as Chukar partridges, and for watersheds. Bezzant and Gappmayer soils in capability unit VIIIe-X nonirrigated, Rock land in capability unit VIIs-X nonirrigated; range site unassigned.

Billings Series

The Billings series consists of well-drained soils that formed in alluvium derived from shale on alluvial fans and alluvial plains. Billings soils are most commonly associated with Mayfield, Ravola, Skumpah, and Woodrow soils. Slopes are typically smooth and are 1 to 5 percent.

Elevation ranges from 5,400 to 5,600 feet. The average annual precipitation ranges from 8 to 12 inches, and the mean annual air temperature ranges from 45° to 49° F. The frost-free period ranges from 115 to 130 days. Vegetation in the noncultivated areas is dominantly big sagebrush, shadscale, cheatgrass, and annual weeds.

In a representative profile the surface layer is light brownish-gray silty clay loam about 11 inches thick. The substratum to a depth of 60 inches is light-gray silty clay loam.

The Billings soils are strongly calcareous, and reaction is strongly alkaline throughout. Permeability is slow. The available water capacity is 8 to 12 inches. The water-supplying capacity of nonirrigated soil is 6 to 8 inches annually. The effective root zone is 5 feet or more.

Billings soils are used mainly for irrigated alfalfa, small grain, and corn for silage. Some areas are used as improved pasture, range, and habitat for upland game birds.

Representative profile of Billings silty clay loam, in a cultivated field, 1,830 feet west and 1,403 feet north of the southeast corner of sec. 19, T. 19 S., R. 2 E., about 1½ miles west of Mayfield, Sanpete County:

Ap1—0 to 3 inches, light brownish-gray (2.5Y 6/2) silty clay loam, grayish brown (2.5Y 5/2) when moist; moderate, fine, granular structure; slightly hard, firm, sticky and plastic; few very fine, fine, and medium pores; strongly calcareous; strongly alkaline (pH 8.6); abrupt, smooth boundary.

Ap2—3 to 11 inches, light brownish-gray (2.5Y 6/2) silty clay loam, grayish brown (2.5Y 5/2) when moist; moderate, medium, subangular blocky structure; hard, firm, sticky and plastic; common very fine, fine, and medium pores; common worm casts; strongly calcareous; strongly alkaline (pH 8.6); clear, smooth boundary.

C1—11 to 20 inches, light-gray (2.5Y 7/2) silty clay loam, light brownish gray (2.5Y 6/2) when moist; weak, medium, subangular blocky structure; very hard, firm, sticky and plastic; common very fine, few fine and medium roots; common very fine, few fine and medium pores; few krotovinas; strongly calcareous; strongly alkaline (pH 8.6); clear, smooth boundary.

C2—20 to 60 inches, light-gray (2.5Y 7/2) silty clay loam, light brownish gray (2.5Y 6/2) when moist; massive; very hard, firm, sticky and plastic; few very fine and fine roots; few very fine, fine, and medium pores; strongly calcareous; strongly alkaline (pH 8.6).

The A horizon is 6 to 11 inches thick. It is light brownish gray, grayish brown to light gray when dry and dark grayish brown to light brownish gray when moist.

The C horizon is grayish brown to light gray when dry and grayish brown to light brownish gray when moist. Texture between depths of 10 and 40 inches is silty clay loam or clay loam.

Bm—Billings silty clay loam. This soil is on alluvial fans and alluvial plains. Slope is 1 to 5 percent. Runoff is medium, and the hazard of erosion is moderate. There is moderate sheet and rill erosion, and there are a few deep gullies in places.

Included with this soil in mapping are small areas of Mayfield shaly loam, 2 to 5 percent slopes, and Ravola loam, 2 to 5 percent slopes.

Most of the acreage of this soil is used for irrigated alfalfa, small grain, corn for silage, and pasture. A few small areas are used as range. Capability units IIIe-25 irrigated, VIIe-S nonirrigated; Semi-desert Loam range site.

Birdow Series

The Birdow series consists of well-drained soils that formed in mixed alluvium derived from sandstone, quartzite, and limestone on flood plains and alluvial fans. Birdow soils are most commonly associated with Beek, Calita, Keigley, and Mountainville soils. Slope is 2 to 8 percent.

Elevation ranges from 5,400 to 6,100 feet. The average annual precipitation ranges from 12 to 14 inches, and the mean annual air temperature ranges from 45° to 47° F. The frost-free period ranges from 110 to 130 days. Vegetation is big sagebrush, bluebunch wheatgrass, scattered oakbrush, and Indian ricegrass.

In a representative profile the surface layer is grayish-brown and brown very fine sandy loam and loam about 30 inches thick. The substratum to a depth of 47 inches is light brownish-gray loam. Below this is an older, buried soil. It is brown clay loam to a depth of 60 inches.

The Birdow soils are moderately calcareous or strongly calcareous, and reaction is mildly alkaline to strongly alkaline. Permeability is moderate. The available water capacity is 8 to 11 inches. The water-supply-

ing capacity is 8 to 10 inches annually. The effective root zone is 5 feet or more.

Birdow soils are used for nonirrigated grain or grass and irrigated alfalfa, pasture, and small grain. They are also used as range.

Representative profile of Birdow very fine sandy loam, 2 to 4 percent slopes, in a cultivated field, 200 feet west and 50 feet north of the southeast corner of sec. 25, T. 14 S., R. 4 E., 2½ miles northwest of Mount Pleasant, Sanpete County:

A11—0 to 3 inches, grayish-brown (10YR 5/2) very fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft, friable, nonsticky and nonplastic; few very fine pores; moderately calcareous; strongly alkaline (pH 8.6); clear, smooth boundary.

A12—3 to 13 inches, brown (10YR 5/3) very fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common fine and few medium roots; moderately calcareous; strongly alkaline (pH 8.6); clear, smooth boundary.

A13—13 to 21 inches, brown (10YR 5/3) very fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky and plastic; common fine roots; common fine pores; moderately calcareous; strongly alkaline (pH 8.6); clear, wavy boundary.

A14—21 to 30 inches, brown (10YR 5/3) loam, dark brown (10YR 3/3) when moist; moderate, medium, subangular blocky structure; hard, friable, slightly sticky and plastic; common fine roots; common fine pores; moderately calcareous; strongly alkaline (pH 8.6); clear, wavy boundary.

C1—30 to 40 inches, light brownish-gray (10YR 6/2) loam, dark brown (10YR 3/3) when moist; moderate, medium, subangular blocky structure; hard, friable, sticky and plastic; few fine roots; few fine pores; moderately calcareous; strongly alkaline (pH 8.6); gradual, wavy boundary.

C2—40 to 47 inches, light brownish-gray (10YR 6/2) loam, dark brown (10YR 3/3) when moist; massive; slightly hard, friable, slightly sticky and plastic; few fine roots; few fine pores; moderately calcareous; strongly alkaline (pH 8.6); gradual, wavy boundary.

A1b—47 to 60 inches, brown (10YR 5/3) clay loam, very dark brown (10YR 2/2) when moist; massive; very hard, friable, sticky and plastic; moderately calcareous, lime in veins; strongly alkaline (pH 8.6).

Texture between depths of 10 and 40 inches is very fine sandy loam, gravelly loam, loam, or silt loam. Content of gravel is as much as 35 percent below a depth of 20 inches.

The A horizon is 20 to 41 inches thick. It is grayish brown, dark brown, reddish brown, or dark grayish brown to brown when dry and dark grayish brown, dark reddish brown, very dark brown, to dark brown or very dark grayish brown when moist. The A horizon ranges from very fine sandy loam to loam or silt loam.

The C horizon is light brownish gray, reddish brown, brown, or grayish brown to pink or very pale brown when dry and dark brown or very dark grayish brown to brown or grayish brown when moist. Below a depth of 40 inches the C horizon ranges from loam to gravelly loam, gravelly sandy loam, or silt loam. In places a buried A1b horizon occurs below the C horizon.

BnB—Birdow very fine sandy loam, 2 to 4 percent slopes. This soil is on flood plains and alluvial fans. It has the profile described as representative of the series. Runoff is medium, and the hazard of erosion is slight.

Included with this soil in mapping are small areas of Keigley silty clay loam, 2 to 4 percent slopes; Beek silty clay loam; and Mountainville very stony sandy loam, 2 to 8 percent slopes.

This soil is used for nonirrigated grain or grass and for irrigated small grain, alfalfa, or pasture. Small areas are used as range. Capability units IIe-2 irrigated, IVe-UZ nonirrigated; Upland Loam range site.

BnC—Birdow very fine sandy loam, 4 to 8 percent slopes. This soil is on flood plains and alluvial fans. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Snake Hollow gravelly fine sandy loam, 2 to 4 percent slopes; Keigley silty clay loam, 2 to 4 percent slopes; and Birdow very fine sandy loam, 2 to 4 percent slopes.

This soil is used for irrigated small grain, alfalfa, and pasture and for nonirrigated small grain and grass. Small areas are used as range. Capability units IIIe-2 irrigated, IVe-UZ nonirrigated; Upland Loam range site.

BoB—Birdow silt loam, 2 to 4 percent slopes. This soil is on flood plains. It has a profile similar to the one described as representative of the series, but it has been overwashed by very strongly calcareous, fluffy silt loam 6 to 20 inches thick. This soil is very hard to till or cultivate because of the loose and fluffy overwash material derived from travertine rock. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Birdow very fine sandy loam, 2 to 4 percent slopes.

This soil is used only for irrigated alfalfa, alfalfa and grass for hay or pasture, and small grain. Capability unit IVs-24 irrigated; range site not assigned.

Borvant Series

The Borvant series consists of somewhat excessively drained soils that are 10 to 20 inches deep over an indurated lime hardpan. These soils formed in alluvium or colluvium derived from limestone and shale on foothills and alluvial fans. Borvant soils are most commonly associated with Doyce, Bagard, Lodar, and Fontreen soils. Slope is 2 to 25 percent.

Elevation ranges from 6,000 to 7,000 feet. The average annual precipitation ranges from 12 to 14 inches, and the mean annual air temperature ranges from 45° to 47° F. The frost-free period is 90 to 110 days. Vegetation is juniper, pinon, big sagebrush, and perennial grasses.

In a representative profile the surface layer is brown and grayish-brown cobbly loam and gravelly loam about 14 inches thick. The upper 5 inches of the substratum is light-gray very gravelly loam. This is underlain by an indurated lime cemented hardpan about 19 inches thick. Below the hardpan to a depth of 60 inches the substratum is light-gray and very pale brown very gravelly and very cobbly loamy sand.

The Borvant soils are strongly calcareous or very strongly calcareous, and reaction is mildly alkaline to very strongly alkaline. Permeability is moderately rapid above the hardpan and very slow in the hardpan. The available water capacity is 2 to 3 inches. The water-supplying capacity is 4 to 5 inches annually. The hardpan restricts root growth, and roots are matted on top of it.

Borvant soils are used as spring and fall range by sheep and cattle and as winter range by deer. They are also used as woodland and as a source of road fill.

Representative profile of Borvant cobbly loam, 8 to 25 percent slopes, eroded, in a range area, 825 feet north and 800 feet east of the southwest corner of sec. 32, T. 11 S., R. 4 E., 1 mile west and ½ mile north of Indianola in a gravel pit, Utah County:

A11—0 to 3 inches, brown (10YR 5/3) cobbly loam, dark brown (10YR 3/3) when moist; moderate, fine, granular structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; 20 percent gravel and 5 percent cobbles; strongly calcareous, lime in fine hardpan fragments; strongly alkaline (pH 8.6); abrupt, smooth boundary.

A12—3 to 8 inches, grayish-brown (10YR 5/2) gravelly loam, dark brown (10YR 3/3) when moist; weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine and few very fine roots; few fine pores; 25 percent gravel and 20 percent cobbles; very strongly calcareous, lime in limestone fragments; strongly alkaline (pH 8.6); clear, smooth boundary.

A13—8 to 14 inches, grayish-brown (10YR 5/2) gravelly loam, dark brown (10YR 3/3) when moist; massive; slightly hard, friable, slightly sticky and plastic; common very fine roots; few very fine pores; 25 percent gravel and 20 percent cobbles; very strongly calcareous, lime in hardpan fragments; strongly alkaline (pH 8.6); abrupt, smooth boundary.

C1ca—14 to 19 inches, light-gray (10YR 7/2) very gravelly loam, light brownish gray (10YR 5/2) when moist; massive; slightly hard, friable, slightly sticky and plastic; few fine, few very fine roots; 70 percent gravel-size fractured hardpan fragments, 5 percent larger than 3 inches in diameter; strongly alkaline (pH 9.0); abrupt, smooth boundary.

C2cam—19 to 30 inches, laminated indurated lime-cemented hardpan, very pale brown (10YR 8/3) in the upper ¼ to ½ inch, the lower part is white (10YR 8/2) when moist; few fine and medium roots matted on the surface; clear, smooth boundary.

C3cam—30 to 38 inches, two distinct white (10YR 8/2), lime-cemented hardpan layers, very pale brown (10YR 7/3) when moist; clear, smooth boundary.

C4ca—38 to 48 inches, light-gray (10YR 7/2) very gravelly loamy sand, grayish brown (10YR 5/2) when moist; single grained; loose, 60 percent gravel and 5 percent cobbles; strongly calcareous, lime coatings on coarse fragments; very strongly alkaline (pH 9.2); clear, wavy boundary.

C5—48 to 60 inches, very pale brown (10YR 8/3) very cobbly loamy sand, brown (10YR 5/3) when moist; single grained; loose, 30 percent gravel, 50 percent cobbles and stones; strongly calcareous, lime coatings on coarse fragments; very strongly alkaline (pH 9.2).

Depth to indurated lime-cemented hardpan ranges from 10 to 20 inches. Texture between a depth of 10 inches and the hardpan ranges from gravelly or very gravelly loam or fine sandy loam to cobbly or very cobbly loam or fine sandy loam and is 35 to 80 percent cobbles and gravel.

The A horizon is 7 to 14 inches thick. It is brown, grayish brown, dark brown, or dark grayish brown when dry and dark brown, very dark brown, or grayish brown when moist.

The Cca horizon ranges from light gray to light reddish brown, pale brown to pink or very pale brown when dry and is light brownish gray to reddish brown, dark brown or dark grayish brown, pink or very pale brown when moist. It is 3 to 13 inches thick. The hardpan is white to very pale brown and is 3 to 20 inches thick. Below the hardpan the C horizon ranges from very cobbly or very stony loam to very cobbly or very stony loamy sand that has 50 to 80 percent coarse fragments, mainly cobbles and stones.

BRD2—Borvant cobbly loam, 8 to 25 percent slopes, eroded. This soil is on alluvial fans and foothills. It has

the profile described as representative of the series (fig. 2). Runoff is medium, and the hazard of erosion is moderate. Stones and cobbles cover 2 to 10 percent of the surface in a few places. There are some rills and sheet and gully erosion. In places gullies have cut into the hardpan.

Included with this soil in mapping are small areas of Lodar very channery loam, 8 to 40 percent slopes; Bagard very stony clay loam, 10 to 40 percent slopes; and Fontreen cobbly loam, 4 to 20 percent slopes. Also included are small areas where the hardpan is below a depth of 20 inches, is discontinuous, or is lacking.

This soil is used as spring and fall range by sheep and cattle and as winter range for deer. The juniper

is harvested for fenceposts and, like pinon, is also used as firewood. The soil is a good source of road fill. Capability unit VIIIs-U nonirrigated; Upland Shallow Hardpan (Juniper-Pinon) range site.

BSE2—Borvant-Bagard complex, 10 to 40 percent slopes, eroded. This mapping unit is on alluvial fans and foothills. It is about 55 percent Borvant cobbly loam, 8 to 25 percent slopes, eroded, on southern and western exposures and on ridges and about 35 percent Bagard very stony clay loam, 10 to 40 percent slopes, on the northern and eastern exposures. Included in mapping are small areas of Sanpitch very stony loam, 8 to 40 percent slopes, and Deer Creek stony silt loam, 6 to 30 percent slopes.

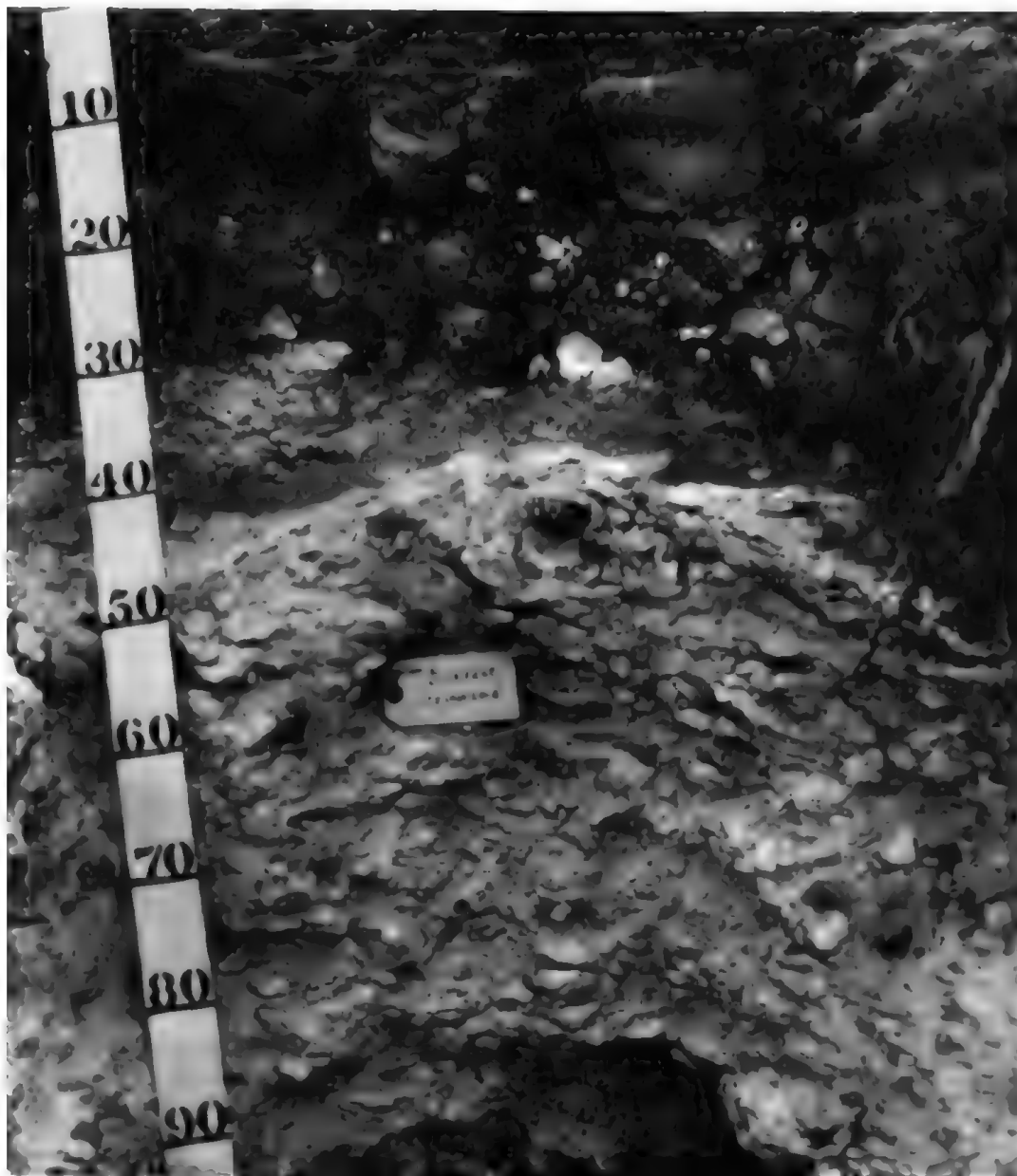


Figure 2.—Borvant cobbly loam, 8 to 25 percent slopes, eroded. Depth is indicated in centimeters.

The Borvant cobbly loam, 8 to 25 percent slopes, eroded, has a profile that is similar to the one described as representative of the series; but stones and cobbles cover 10 to 25 percent of the surface, mainly on the ridges, and in places where the vegetation is sparse the surface layer is only 3 to 5 inches thick. Runoff is medium, and the hazard of erosion is moderate. Sheet erosion is active, and rills are in most areas.

Runoff is medium on the Bagard soils, and the hazard of erosion is moderate. Vegetation is big sagebrush, bluebunch wheatgrass, Indian ricegrass, bitterbrush, cliffrose, yellowbrush, cheatgrass, and scattered juniper.

These soils are used as spring and fall range by sheep and cattle and as winter range by deer and elk. Capability unit VIIs-U nonirrigated; Borvant soil in Upland Shallow Hardpan (Juniper-Pinon) range site, Bagard soil in Upland Stony Loam (Juniper-Pinon) range site.

BTC—Borvant-Doyce complex, 2 to 10 percent slopes. This mapping unit is on alluvial fans. It is about 55 percent Borvant very stony loam, 2 to 10 percent slopes, on ridges and in strongly sloping areas; 30 percent Doyce loam, 2 to 4 percent slopes, in swales and on lower fans; about 15 percent Donnardo very stony loam, 4 to 16 percent slopes; and small areas of Mountainville very stony sandy loam, 2 to 8 percent slopes. Also included are small areas where the hardpan is between depths of 20 and 40 inches.

The Borvant very stony loam, 2 to 10 percent slopes, has a profile similar to the one described as representative of the Borvant series, but stones cover 10 to 25 percent of the surface and fine hardpan fragments are scattered over the surface. Runoff is medium, and the hazard of erosion is moderate. Runoff on the Doyce soils is slow, and the hazard of erosion is moderate.

This mapping unit is used as spring and fall range by sheep and cattle and as winter range by deer. The juniper is harvested for posts and, like the pinon, is used for firewood. The Borvant soil is a good source of road fill. Capability unit VIIs-U nonirrigated; Borvant soil in Upland Shallow Hardpan range site, Doyce soil in Upland Loam range site.

BUD2—Borvant-Lodar complex, 8 to 25 percent slopes, eroded. This mapping unit is on alluvial fans and foothills. It is about 55 percent Borvant cobbly loam, 8 to 25 percent slopes, eroded, mainly on the northern and eastern exposures; about 30 percent Lodar very channery loam, 8 to 40 percent slopes, mainly on the southern side slopes and ridges; about 15 percent Fontreen very cobbly loam, 20 to 40 percent slopes, eroded; and small areas of Atepic shaly clay loam, 10 to 30 percent slopes, eroded.

The Borvant cobbly loam, 8 to 25 percent slopes, eroded, has a profile similar to the one described as representative of the series, but stones and cobbles cover 10 to 25 percent of the surface in some places, and limestone is below a depth of 30 inches in some areas. Runoff is medium, and the hazard of erosion is moderate.

Runoff on the Lodar soils is medium, and the hazard of erosion is moderate.

This mapping unit is used as spring and fall range

by sheep and cattle and as winter range by deer and elk. The juniper is harvested for posts and, like the pinon, it is used for firewood. The Borvant soil is a good source of road fill, except for those areas that are moderately deep over bedrock. Capability unit VIIs-U nonirrigated; Borvant soil in Upland Shallow Hardpan (Juniper-Pinon) range site, Lodar soil in Upland Shallow Loam (Juniper-Pinon) range site.

Bradshaw Series

The Bradshaw series consists of well-drained soils that formed in colluvium derived from sandstone on mountainsides. Bradshaw soils are most commonly associated with Adel, Daybell, Gappmayer, and Harkers soils. Slope is 60 to 80 percent.

Elevation ranges from 6,500 to 7,500 feet. The average annual precipitation ranges from 20 to 22 inches, and the mean annual air temperature ranges from 40° to 44° F. The frost-free period ranges from 80 to 100 days. Vegetation is oakbrush, serviceberry, cheatgrass, and perennial grasses.

In a representative profile the surface layer is brown very stony loam and cobbly fine sandy loam about 19 inches thick. The subsoil is light yellowish-brown cobbly very fine sandy loam about 12 inches thick. The substratum to a depth of 60 inches is brown very cobbly fine sandy loam.

Reaction is slightly acid to mildly alkaline. Permeability is moderately rapid. The available water capacity is 3 to 5 inches. The water-supplying capacity is 7 to 9 inches annually. The effective root zone is 5 feet or more.

Bradshaw soils are used mainly as summer range by deer and elk and are important as watershed.

Representative profile of Bradshaw very stony loam, 60 to 80 percent slopes, in a range area, 1,650 feet east and 2,640 feet north of the southwest corner of sec. 10, T. 10 S., R. 3 E., south of Crab Creek on Loafer Mountain, Utah County:

A11—0 to 7 inches, brown (10YR 4/3) very stony loam, very dark brown (10YR 2/3) when moist; weak, fine, granular structure; slightly hard, friable, nonsticky and slightly plastic; common very fine roots; few very fine pores; stones cover 10 to 25 percent of the surface; slightly acid (pH 6.2); clear, smooth boundary.

A12—7 to 12 inches, brown (10YR 5/3) cobbly fine sandy loam, dark brown (10YR 3/3) when moist; weak, fine, granular structure; slightly hard, friable, slightly sticky and slightly plastic; few fine, common very fine roots; few very fine pores; 25 percent cobbles and gravel; slightly acid (pH 6.2); clear, smooth boundary.

A13—12 to 19 inches, brown (10YR 5/3) cobbly fine sandy loam, dark brown (10YR 3/3) when moist; moderate, fine, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine and few medium roots; few very fine pores; 40 percent cobbles and gravel; slightly acid (pH 6.4); clear, wavy boundary.

B2—19 to 31 inches, light yellowish-brown (10YR 6/4) cobbly very fine sandy loam, dark yellowish brown (10YR 4/4) when moist; moderate, fine, subangular blocky structure; hard, friable, slightly sticky and plastic; few fine roots; few very fine pores; 40 percent cobbles, gravel, and stones; slightly acid (pH 6.5); clear, wavy boundary.

C—31 to 60 inches, brown (10YR 5/3) very cobbly fine sandy loam, dark brown (10YR 4/3) when moist; massive; slightly hard, friable, slightly sticky and

plastic; few very fine roots; few very fine pores; 55 percent cobbles, gravel, and stones; slightly acid (pH 6.2).

Depth to bedrock is about 60 inches. Texture between depths of 10 and 40 inches is gravelly or very gravelly to cobbly or very cobbly very fine sandy loam or fine sandy loam.

The A horizon is 10 to 20 inches thick. It is brown or dark grayish brown to grayish brown when dry and very dark brown to dark brown or very dark grayish brown when moist.

The B2 horizon is 10 to 24 inches thick. It is light yellowish brown, brown, yellowish brown, or pale brown when dry and dark yellowish brown, brown, or yellowish brown when moist.

The C horizon is brown or grayish brown to light brown or pale brown when dry and dark brown to brown when moist.

BVG—Bradshaw very stony loam, 60 to 80 percent slopes. This soil is on mountainsides. Runoff is medium, and the hazard of erosion is high.

Included with this soil in mapping are small areas of Bezzant very stony loam, 60 to 80 percent slopes; Daybell gravelly silt loam, 40 to 70 percent slopes; and a soil that is at a depth of 20 to 40 inches over sandstone bedrock. Also included are 5 to 10 percent Rock outcrop on points and ridges.

This soil is used mainly as summer range by deer and elk and as catchment areas for watersheds. Capability unit VIIIe-X nonirrigated; range site not assigned.

Cache Series

The Cache series consists of poorly drained soils that formed in alluvium derived from shale and limestone on flood plains and valley bottoms. Cache soils are commonly associated with Abcal and Shumway soils. Slope is 0 to 2 percent.

Elevation ranges from 5,100 to 5,600 feet. The average annual precipitation ranges from 8 to 12 inches, and the mean annual air temperature ranges from 47° to 51° F. The frost-free period ranges from 115 to 130 days. Vegetation is a very sparse stand of salt-grass and greasewood.

In a representative profile the surface layer is light-gray silty clay loam about 2 inches thick. The substratum is white silty clay to a depth of 12 inches and light-gray silty clay and clay to a depth of 60 inches.

The surface layer is strongly calcareous, and the substratum is strongly calcareous and very strongly calcareous. Permeability is slow. The available water capacity is 1 to 3 inches. The soil is very strongly saline above a depth of 20 inches. The high salt content reduces the amount of water available to plants. The seasonal water table ranges between depths of 20 and 40 inches. The effective root zone is 5 feet or more.

Cache soils are used to a very limited extent for grazing. They are mapped only with Abcal soils.

Representative profile of Cache silty clay, in an area of Abcal-Cache complex, in a native pasture about 3 miles southwest of Manti, 2,640 feet south and 2,310 feet west of the northeast corner of sec. 3, T. 18 S., R. 2 E., Sanpete County:

A11sa—0 to ½ inch, light-gray (10YR 7/2) silt loam, grayish brown (10YR 5/2) when moist; moderate, fine,

granular structure; slightly hard, friable, slightly sticky and plastic; mainly salt crust; strongly calcareous; very strongly alkaline (pH 9.4); abrupt, smooth boundary.

A12sa—½ to 2 inches, light-gray (10YR 7/2) silty clay loam, grayish brown (10YR 5/2) when moist; weak, thick, platy structure that parts to moderate, fine, granular; slightly hard, firm, slightly sticky and plastic; common fine pores; numerous salt crystals when dry; strongly calcareous; very strongly alkaline (pH 9.4); abrupt, smooth boundary.

C1sa—2 to 12 inches, white (2.5Y 8/2) silty clay, light gray (2.5Y 7/2) when moist; moderate, fine, angular blocky structure; very hard, very firm, sticky and plastic; few very fine pores; numerous salt crystals when dry; very strongly calcareous; very strongly alkaline (pH 9.4); clear, smooth boundary.

C2sa—12 to 36 inches, light-gray (10YR 7/2) silty clay, light brownish gray (10YR 6/2) when moist; massive; very hard, extremely firm, sticky and very plastic; very strongly saline; strongly calcareous; very strongly alkaline (pH 9.4); gradual, wavy boundary.

C3—36 to 43 inches, light-gray (10YR 7/2) silty clay, light brownish gray (10YR 6/2) when moist; common, fine, distinct, yellowish-brown (10YR 5/6) mottles; moderately saline; strongly calcareous; strongly alkaline (pH 8.8); gradual, wavy boundary.

C4—43 to 60 inches, light-gray (5Y 7/2) clay, olive gray (5Y 5/2) when moist; many medium, distinct, yellowish-brown (10YR 5/6) mottles; moderately saline; strongly calcareous; strongly alkaline (pH 8.6).

Reaction ranges from strongly alkaline to very strongly alkaline. Soluble salt content ranges from 2 to 5 percent to a depth of 30 inches. Depth to mottling is between 20 and 40 inches. Texture between depths of 10 and 40 inches is dominantly silty clay or clay.

The A horizon is 1 to 4 inches thick. It is grayish brown to light gray when dry and is dark grayish brown to grayish brown when moist.

The C horizon is white to grayish brown, olive gray, light gray, or light olive gray when dry and light brownish gray, dark grayish brown, light gray, olive gray, or light olive gray when moist.

Calita Series

The Calita series consists of well-drained soils that formed in alluvium derived from limestone, sandstone, and shale on alluvial fans. Calita soils are most commonly associated with Birdow, Donnardo, Doyce, and Keigley soils. Slope is 2 to 8 percent.

Elevation ranges from 5,700 to 6,200 feet. The average annual precipitation ranges from 12 to 14 inches, and the mean annual air temperature is 45° to 49° F. The frost-free period ranges from 110 to 120 days. Vegetation is dominantly big sagebrush, rabbitbrush, western wheatgrass, and annual weeds.

In a representative profile the surface layer is dark grayish-brown and brown loam about 7 inches thick. The subsoil is brown sandy clay loam about 5 inches thick. The substratum to a depth of 60 inches is pink sandy clay loam, loam, and clay loam.

Calita soils are strongly calcareous, and reaction is mildly alkaline to strongly alkaline. Permeability is moderate. The available water capacity is 8 to 11 inches. The water-supplying capacity of nonirrigated soils is 8 to 10 inches annually. The effective root zone is 5 feet or more.

Calita soils are used for irrigated and nonirrigated alfalfa and grass and for irrigated small grain. Small areas are used as range.

Representative profile of Calita loam, 2 to 4 percent slopes, 3 miles south of Fountain Green on the Foun-

tain Green to Wales Highway and $\frac{1}{4}$ mile east of the highway, about 1,580 feet south and 477 feet east of the northwest corner of sec. 19, T. 14 S., R. 3 E., Sanpete County:

- A11—0 to 2 inches, dark grayish-brown (10YR 4/2) loam, very dark brown (10YR 2/2) when moist; weak, fine, granular structure; soft, very friable, slightly sticky and plastic; few fine and very fine roots; few fine pores; slightly calcareous; mildly alkaline (pH 7.4); abrupt, smooth boundary.
- A12—2 to 7 inches, brown (10YR 5/3) loam, dark brown (10YR 3/3) when moist; weak, medium, subangular blocky structure; slightly hard, firm, slightly sticky and plastic; few fine and very fine roots; few fine pores; strongly calcareous; moderately alkaline (pH 8.0); clear, smooth boundary.
- B2—7 to 12 inches, brown (7.5YR 5/3) sandy clay loam, dark brown (7.5YR 4/3) when moist; weak, medium, subangular blocky structure; slightly hard, firm, slightly sticky and plastic; few fine and very fine roots; few very fine pores; strongly calcareous; moderately alkaline (pH 8.4); clear, smooth boundary.
- C1ca—12 to 23 inches, pink (7.5YR 8/3) sandy clay loam, light brown (7.5YR 6/3) when moist; massive; very hard, firm, sticky and plastic; few very fine roots; few very fine pores; strongly calcareous, lime in soft rounded masses and veins; strongly alkaline (pH 9.0); clear, wavy boundary.
- C2ca—23 to 30 inches, pink (7.5YR 7/3) loam, light brown (7.5YR 6/3) when moist; massive; hard, friable, slightly sticky and slightly plastic; few very fine pores; strongly calcareous, lime in veins; strongly alkaline (pH 9.0); clear, wavy boundary.
- C3—30 to 45 inches, pink (7.5YR 7/3) loam, brown (7.5YR 5/4) when moist; massive; very hard, friable, slightly sticky and slightly plastic; few very fine pores; strongly calcareous; strongly alkaline (pH 8.8); gradual, wavy boundary.
- C4—45 to 60 inches, pink (7.5YR 7/3) clay loam, brown (7.5YR 5/4) when moist; massive; very hard, firm, sticky and plastic; few very fine pores; strongly calcareous; strongly alkaline (pH 9.0).

Texture between depths of 10 and 40 inches is heavy loam, sandy clay loam, or clay loam.

The A horizon is 7 to 14 inches thick. It is dark brown or dark grayish brown to brown or grayish brown when dry and is very dark brown to dark brown or very dark grayish brown when moist. Reaction is mildly alkaline to strongly alkaline.

The B2 horizon is 3 to 9 inches thick. It is brown or grayish brown to light brown or light yellowish brown when dry and dark brown or very dark grayish brown to brown or dark grayish brown when moist.

The Cca horizon is pink, reddish brown, brown, or very pale brown when dry and light brown, reddish brown, or brown to pink or very pale brown when moist. Reaction is moderately alkaline to strongly alkaline.

The C horizon is similar in color and reaction to the Cca horizon. Below a depth of 40 inches the C horizon ranges from clay loam to fine sandy loam.

CaB—Calita loam, 2 to 4 percent slopes. This soil is on alluvial fans. It has the profile described as representative of the series. Runoff is medium, and the hazard of erosion is moderate. In small areas the content of lime exceeds 40 percent between depths of 10 and 40 inches. Gravel and cobbles are on the surface in a few places.

Included with this soil in mapping are small areas of Donnardo cobbly loam, 4 to 16 percent slopes, and Doyce loam, 2 to 4 percent slopes.

This soil is used mainly for irrigated alfalfa, pasture, and small grain and for nonirrigated small grain and grass. Small areas are used as range. Capability units

Ile-2 irrigated, IVE-UZ nonirrigated; Upland Loam range site.

CaC—Calita loam, 4 to 8 percent slopes. This soil is on alluvial fans. Runoff is medium, and the hazard of erosion is severe.

Included with this soil in mapping are small areas of Donnardo cobbly loam, 4 to 16 percent slopes; Calita loam, 2 to 4 percent slopes; and Doyce loam, 4 to 8 percent slopes.

This soil is used for irrigated small grain, alfalfa, and pasture, and nonirrigated small grain. It is also used as range. Capability units Ile-2 irrigated, IVE-UZ nonirrigated; Upland Loam range site.

Canburn Series

The Canburn series consists of poorly drained soils that formed in alluvium derived from limestone, sandstone, and shale on alluvial fans and in valley bottoms. Canburn soils are most commonly associated with Beek, Manila, Toehead, and Watkins Ridge soils. Slope is 0 to 2 percent.

Elevation ranges from 5,800 to 6,500 feet. The average annual precipitation ranges from 12 to 14 inches, and the mean annual air temperature ranges from 43° to 45° F. The frost-free period is 100 to 120 days. Vegetation includes sedges, wiregrass, cinquefoil, and foxtail.

In a representative profile the surface layer is grayish-brown silty clay loam about 25 inches thick. The substratum to a depth of 60 inches is light brownish-gray and grayish-brown clay loam.

The Canburn soils are moderately calcareous to strongly calcareous, and reaction is moderately alkaline to strongly alkaline. Permeability is moderately slow. The available water capacity is 8 to 12 inches. The seasonal water table ranges from the surface to a depth of 50 inches. Roots penetrate to a depth of 5 feet or more.

Canburn soils are used for grass pasture and native grass hay. Springs and seeps on these soils provide water for livestock and irrigation.

Representative profile of Canburn silty clay loam in a wet meadow pasture, at the south end of the Millburn bottoms, about 600 feet north and 1,700 feet west of the southeast corner of sec. 11, T. 13 S., R. 4 E., Sanpete County:

- A11—0 to 3 inches, grayish-brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, subangular blocky structure; hard, firm, sticky and plastic; many very fine and fine roots; few very fine pores; strongly calcareous; moderately alkaline (pH 8.2); clear, smooth boundary.
- A12—3 to 8 inches, grayish-brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; few, medium, distinct, dark-brown (7.5YR 5/4) mottles; moderate, fine, subangular blocky structure; hard, firm, sticky and plastic; few fine and medium roots; few fine and medium pores; strongly calcareous; strongly alkaline (pH 8.6); clear, smooth boundary.
- A13—8 to 16 inches, grayish-brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; common, medium, distinct, yellowish-brown (10YR 5/5) mottles; moderate, fine, subangular blocky structure; hard, firm, sticky and plastic; few fine and medium roots; few fine and medium pores; strongly calcareous; strongly alkaline (pH 8.8); gradual, smooth boundary.

A14—16 to 25 inches, grayish-brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) when moist; common, fine, distinct, dark-brown (7.5YR 4/4) mottles; weak, fine, subangular blocky structure; hard, firm, sticky and plastic; few medium and fine roots; few fine pores; strongly calcareous; strongly alkaline (pH 8.8); gradual, smooth boundary.

C1—25 to 45 inches, light brownish-gray (10YR 6/2) clay loam, very dark grayish brown (10YR 3/2) when moist; massive; hard, firm, sticky and plastic; few fine roots; strongly calcareous; strongly alkaline (pH 8.8); gradual, smooth boundary.

C2—45 to 60 inches, grayish-brown (10YR 5/2) clay loam, dark brown (10YR 3/3) when moist; massive; hard, firm, sticky and plastic; few fine roots; strongly calcareous; strongly alkaline (pH 8.8).

Distinct or prominent mottles are at a depth above 20 inches. Texture between depths of 10 to 40 inches ranges from heavy loam to clay loam.

The A horizon is 24 to 35 inches thick. It is dark grayish brown or grayish brown to dark brown or brown when dry and very dark brown or very dark grayish brown to dark brown when moist.

The C horizon is brown or grayish brown to light brownish gray or pale brown when dry and dark brown, very dark grayish brown, dark grayish brown, or brown when moist. Thin stratification of sand or sandy loam is in some places.

Cb—Canburn silty clay loam. This soil is on the lower end of alluvial fans and on valley bottoms. Slope is 0 to 2 percent. Runoff is slow to ponded, and the hazard of erosion is slight. Water ponds in spring or after heavy storms, and seeps and springs are common.

Included with this soil in mapping are small areas of Beek silty clay loam; Toehead silt loam, 2 to 4 percent slopes; and Watkins Ridge silt loam, 1 to 6 percent slopes.

This soil is used for grass pasture and native grass hay. The springs and seeps provide water for livestock and for irrigation. Capability unit Vw-2 nonirrigated; Wet Meadows range site.

Centerfield Series

The Centerfield series consists of somewhat excessively drained soils that formed in alluvium derived from shale and limestone on alluvial fans and flood plains of streams. Centerfield soils are most commonly associated with Dyreng, Genola, and Woodrow soils. Slopes are typically smooth and are 0 to 5 percent.

Elevation ranges from 5,200 to 6,000 feet. The average annual precipitation ranges from 8 to 12 inches, and the mean annual air temperature ranges from 45° to 59° F. The frost-free period ranges from 110 to 130 days. Vegetation in the noncultivated areas is dominantly big sagebrush, rabbitbrush, shadscale, and Indian ricegrass.

In a representative profile the surface layer is pale-brown silt loam and very pale brown silty clay loam about 8 inches thick. The substratum is very pale brown clay loam and gravelly clay loam to a depth of 20 inches, and pale-brown very gravelly sandy loam and pale-brown very gravelly loamy sand to a depth of 60 inches.

Centerfield soils are strongly calcareous to very strongly calcareous, and reaction is moderately alkaline to strongly alkaline. Content of gravel and cobbles is 40 to 80 percent below a depth of 20 inches. Permeability is moderately slow to a depth of 20 inches

and rapid below. The available water capacity is 4 to 7 inches. The water-supplying capacity of nonirrigated soils is 4 to 8 inches annually. The effective root zone is 5 feet or more.

Centerfield soils are used for irrigated alfalfa, small grain, and pasture. These soils are used as range and as habitat for upland game birds. They are also a good source of road fill.

Representative profile of Centerfield silty clay loam, 1 to 2 percent slopes, in a field $\frac{1}{4}$ mile west of Centerfield, about 2,085 feet north and 1,770 feet west of the southeast corner of sec. 29, T. 19 S., R. 1 E., Sanpete County:

A11—0 to $\frac{1}{2}$ inch, pale-brown (10YR 6/3) silt loam; dark brown (10YR 4/3) when moist; weak, medium, platy structure; slightly hard, firm, sticky and plastic; many very fine vesicular pores; strongly calcareous; moderately alkaline (pH 8.0); abrupt, smooth boundary.

A12— $\frac{1}{2}$ to 3 inches, pale-brown (10YR 6/3) silt loam, dark brown (10YR 4/3) when moist; moderate, thick, platy structure that parts to moderate, fine, granular; slightly hard, firm, sticky and plastic; few very fine roots; few very fine pores; strongly calcareous; moderately alkaline (pH 8.2); clear, smooth boundary.

A13—3 to 8 inches, very pale brown (10YR 7/3) silty clay loam, brown (10YR 5/3) when moist; moderate, medium, subangular blocky structure; hard, firm, sticky and plastic; few very fine roots; few medium pores; strongly calcareous; moderately alkaline (pH 8.3); clear, smooth boundary.

C1—8 to 16 inches, very pale brown (10YR 7/3) clay loam, light yellowish brown (10YR 6/4) when moist; moderate, medium, subangular blocky structure; hard, firm, sticky and plastic; few very fine roots; common very fine and few medium pores; 5 to 10 percent gravel; strongly calcareous; moderately alkaline (pH 8.4); gradual, smooth boundary.

C2—16 to 20 inches, very pale brown (10YR 7/3) gravelly clay loam, light yellowish brown (10YR 6/4) when moist; massive; hard, firm, sticky and plastic; few very fine roots; common very fine and fine pores; 20 to 30 percent gravel; very strongly calcareous; moderately alkaline (pH 8.4); clear, smooth boundary.

C3—20 to 25 inches, very pale brown (10YR 7/3) very gravelly sandy loam, brown (10YR 5/3) when moist; massive; loose, very friable, slightly sticky and slightly plastic; few very fine roots; few fine pores; 70 percent gravel and cobbles; very strongly calcareous; moderately alkaline (pH 8.3); gradual, wavy boundary.

C4—25 to 60 inches, pale-brown (10YR 6/3) very gravelly loamy sand, dark brown (10YR 4/3) when moist; single grained; loose; 65 percent gravel and cobbles; very strongly calcareous; moderately alkaline (pH 8.3).

Texture between depths of 10 and 20 inches is silt loam, clay loam, gravelly clay loam, or silty clay loam. Between depths of about 20 and 40 inches it is gravelly or very gravelly sandy loam or loamy sand to cobbly or very cobbly sandy loam or loamy sand. Content of gravel and cobbles ranges from 40 to 80 percent.

The A horizon is 6 to 10 inches thick. It is pale brown, light brown, pink, or very pale brown when dry and dark brown and brown to grayish brown when moist. It ranges from silt loam to silty clay loam.

The C horizon is very pale brown, light brown, pinkish gray, or pale brown when dry and brown to light yellowish brown, dark brown, or light brown when moist.

CcB—Centerfield silty clay loam, 1 to 2 percent slopes. This soil is on stream flood plains. It has the profile described as representative of the series. Runoff is slow, and the hazard of erosion is slight. In places some gravel or cobbles are on the surface.

Included with this soil in mapping are small areas of Wales silty clay loam, low rainfall, 0 to 2 percent

slopes; Sigurd gravelly loam, 1 to 5 percent slopes; and Woodrow silty clay loam, 0 to 2 percent slopes.

Most of the acreage is used for irrigated alfalfa, small grain, and pasture. Small areas are used as range. This soil is also a source of road fill. Capability units IIe-2 irrigated, VIIe-S nonirrigated; Semi-desert Loam range site.

CcC2—Centerfield silty clay loam, 2 to 5 percent slopes, eroded. This soil is on alluvial fans. It has a profile similar to the one described as representative of the series, but it is moderately eroded. Runoff is medium, and the hazard of erosion is severe. Sheet and rill erosion are common, and there are a few gullies.

Included with this soil in mapping are small areas of Sanpete cobbly fine sandy loam, 5 to 10 percent slopes, eroded, and Wales silty clay loam, low rainfall, 2 to 5 percent slopes.

This soil is used mainly for irrigated alfalfa and pasture. It is also used as range and as habitat by upland birds and small game. Capability units IIIe-2 irrigated, VIIe-S nonirrigated; Semi-desert Loam range site.

Cheadle Series

The Cheadle series consists of excessively drained soils that are 10 to 20 inches deep over sandstone bedrock. These soils formed in residuum and colluvium derived from sandstone and limestone on mountainsides and ridges. They are most commonly associated with Adel, Daybell, Flygare, and Tingey soils. Slope is 40 to 70 percent.

Elevation ranges from 8,800 to 9,300 feet. The average annual precipitation ranges from 20 to 30 inches, which falls mostly as snow, and the mean annual air temperature is about 40° F. The frost-free period is 70 to 90 days. Vegetation includes black sagebrush, fringed sagewort, and perennial grasses.

In a representative profile the surface layer is very dark grayish-brown and dark-brown very flaggy silt loam about 9 inches thick. The substratum is brown very flaggy sandy loam about 10 inches thick. Sandstone bedrock is at a depth of about 19 inches.

Permeability is rapid. Reaction is neutral to moderately alkaline. The available water capacity is 1 to 2 inches. The water-supplying capacity is 6 to 7 inches annually. The effective root zone is limited by the bedrock, but roots extend into bedrock fractures. Generally a thin root mat forms on the bedrock.

Cheadle soils are used as range.

Representative profile of Cheadle very flaggy silt loam, 40 to 70 percent slopes, in range area on Loafer Mountain, $\frac{3}{4}$ mile south of the microwave reflector tower on the ridge, about 200 feet south and 100 feet west of the northeast corner of sec. 33, T. 9 S., R. 3 E., Utah County:

A11—0 to 4 inches, very dark grayish-brown (10YR 3/2) very flaggy silt loam, very dark brown (10YR 2/2) when moist; weak, fine, granular structure; soft, friable, nonsticky and slightly plastic; many very fine and few fine roots; few very fine pores; 3 percent of the surface is covered by flagstones; mildly alkaline (pH 7.4); clear, smooth boundary.

A12—4 to 9 inches, dark-brown (10YR 4/3) very flaggy

silt loam, dark brown (10YR 3/3) when moist; massive; soft, friable, slightly sticky and slightly plastic; many very fine roots; few fine pores; 75 percent flagstones; slightly calcareous, lime coatings on bottom of rock fragments; mildly alkaline (pH 7.8); clear, smooth boundary.

C—9 to 19 inches, brown (10YR 5/3) very flaggy sandy loam, dark brown (10YR 3/3) when moist; massive; soft, friable, slightly sticky and slightly plastic; common fine roots; 80 percent angular fragments, with unfilled spaces between flagstones; moderately calcareous, lime coatings on the bottom of flagstones; moderately alkaline (pH 8.0); abrupt, wavy boundary.

R—19 inches, thinly bedded sandstone that has some fractures.

Depth to bedrock is 10 to 20 inches. Texture between a depth of 10 inches and bedrock ranges from very flaggy silt loam to very flaggy sandy loam. Content of rock fragments, which are mainly flagstones, ranges from 50 to 80 percent.

The A horizon is 6 to 9 inches thick. It is very dark grayish brown, dark brown, dark grayish brown, or brown when dry and very dark brown to dark brown or very dark grayish brown when moist. The A horizon is noncalcareous to slightly calcareous.

The C horizon is 4 to 11 inches thick. It is brown or dark grayish brown to grayish brown when dry and dark brown or very dark grayish brown when moist. The C horizon is slightly calcareous to moderately calcareous, and lime coats the bottom of the flagstones.

CDG—Cheadle very flaggy silt loam, 40 to 70 percent slopes. This soil is on mountainsides and ridges. Runoff is rapid, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Rock land; Adel silt loam, 40 to 80 percent slopes; and Daybell gravelly silt loam, 40 to 70 percent slopes.

This soil is used as summer range by sheep and cattle and as habitat by wildlife. Capability unit VIIe-M nonirrigated; Mountain Shallow Loam range site.

Chipman Series

The Chipman series consists of poorly drained soils that formed in alluvium derived from limestone, sandstone, and shale on valley bottoms. Chipman soils are most commonly associated with Keigley, Poganeab variant, and Birdow soils. Slope is 0 to 2 percent.

Elevation ranges from 5,500 to 6,000 feet. The average annual precipitation ranges from 12 to 14 inches, and the mean annual air temperature is about 49° F. The frost-free period is 100 to 120 days. Vegetation is wiregrass, sedges, redtop grass, and white Dutch clover.

In a representative profile the surface layer is grayish-brown and dark-gray silty clay loam about 12 inches thick. The substratum is light-gray silty clay loam to a depth of 26 inches and pinkish-gray silty clay loam to a depth of 60 inches.

Chipman soils are strongly calcareous, and reaction is moderately alkaline to strongly alkaline. Permeability is moderately slow. The available water capacity is 8 to 12 inches. The effective root zone is 5 feet or more. The seasonal water table fluctuates between depths of 10 and 30 inches.

Chipman soils are used for grass pasture and native grass hay.

Representative profile of Chipman silty clay loam, in a pasture area, about $1\frac{1}{2}$ miles west and $\frac{1}{4}$ mile north of Moroni, about 2,145 feet north and 2,145

feet west of the southeast corner of sec. 8, T. 15 S., R. 3 E., Sanpete County:

- A1—0 to 4 inches, grayish-brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, granular structure; very hard, firm, sticky and plastic; common fine roots; common fine and very fine pores; strongly calcareous; moderately alkaline (pH 8.4); clear, smooth boundary.
- A12—4 to 12 inches, dark-gray (10YR 4/1) silty clay loam, very dark gray (10YR 3/1) when moist; few, fine, distinct, strong-brown (7.5YR 5/8) mottles; weak, medium, subangular blocky structure; very hard, firm, sticky and plastic; many fine and very fine roots; common fine and very fine pores; strongly calcareous; moderately alkaline (pH 8.4); clear, smooth boundary.
- C1ca—12 to 18 inches, light-gray (10YR 6/1) silty clay loam, gray (10YR 5/1) when moist; many, fine, distinct, strong-brown (7.5YR 5/8) mottles; massive, very hard, firm, sticky and plastic; common fine roots; common fine pores; strongly calcareous, lime in nodules; moderately alkaline (pH 8.2); clear, smooth boundary.
- C2ca—18 to 26 inches, light-gray (10YR 7/2) silty clay loam, light brownish gray (10YR 6/2) when moist; common, fine, distinct, strong-brown (10YR 5/8) mottles; massive; very hard, firm, sticky and plastic; few fine roots; common fine pores; strongly calcareous, lime in nodules; moderately alkaline (pH 8.2); clear, smooth boundary.
- C3—26 to 44 inches, pinkish-gray (7.5YR 6/2) silty clay loam, brown (7.5YR 6/2) when moist; massive; very hard, firm, sticky and plastic; no roots; few very fine pores; strongly calcareous; moderately alkaline (pH 8.2); clear, smooth boundary.
- C4—44 to 60 inches, pinkish-gray (7.5YR 6/2) silty clay loam; brown (7.5YR 5/2) when moist; massive; very hard, firm, sticky and plastic; no roots; strongly calcareous; moderately alkaline (pH 8.2).

The soil is more than 60 inches deep. There are distinct or prominent mottles or soil colors of gray, dark gray, or very dark gray above a depth of 20 inches. Between depths of 10 and 40 inches texture averages silty clay loam or clay loam, but thin layers of clay to fine sandy loam occur.

The A horizon is 7 to 16 inches thick. It is grayish brown, dark gray, or dark grayish brown to gray when dry and very dark grayish brown, black, or very dark brown to very dark gray when moist.

The Cca horizon is light gray or gray to pinkish gray or light brownish gray when dry and very dark gray or very dark grayish brown to gray, grayish brown, or light brownish gray when moist. The Cca horizon is 12 to 28 inches thick. The content of lime ranges from 30 to 50 percent but averages less than 40 percent.

The C horizon is pinkish gray, gray, pale brown, light gray, pink, or very pale brown when dry and brown, dark gray, dark grayish brown, gray, or grayish brown when moist. Below depths of 40 inches it ranges from silt loam to silty clay loam, and content of lime ranges from 20 to 40 percent.

Ch—Chipman silty clay loam. This soil is on valley bottoms. It has the profile described as representative of the series. Slope is 0 to 2 percent. Runoff is slow, and the hazard of erosion is slight. Water ponds in spring or after heavy storms in some areas, and there are springs and seeps.

Included with this soil in mapping are small areas of Beek silty clay loam; Poganeab silt loam, high lime variant; Poganeab silt loam; and a very poorly drained soil around the seep or spring areas. West of Manti's River Road in a small valley about 100 acres of a very dark gray clay soil is included. It is used for pasture.

This Chipman soil is used for grass pasture and for native grass hay. The springs and seeps on this soil provide water for livestock in summer and winter and

for irrigation. Capability unit Vw-2 nonirrigated; Wet Meadows range site.

Cm—Chipman complex. This mapping unit is on the valley bottoms. It is about 55 percent Chipman silty clay loam that is usually in the lower areas; about 35 percent Poganeab silt loam, high lime variant, in the higher areas; small areas of Beek silty clay loam; and small areas of Birdow very fine sandy loam, 2 to 4 percent slopes.

Runoff is slow on both Chipman and Poganeab soils, and the hazard of erosion is slight on Chipman soils and none to slight on Poganeab soils.

This unit is used for grass pasture and for native grass hay. Capability unit Vw-2 nonirrigated; Wet Meadows range site.

Clegg Series

The Clegg series consists of well-drained soils that formed in alluvium derived from limestone, sandstone, and shale in small valleys and on alluvial fans. Clegg soils are most commonly associated with Ant Flat, Deer Creek, Lizzant, and Mower soils. Slope is 3 to 10 percent.

Elevation ranges from 6,500 to 7,500 feet. The average annual precipitation ranges from 14 to 16 inches, and the mean annual air temperature ranges from 40° to 45° F. The frost-free period is 90 to 100 days. Vegetation is mainly big sagebrush, scattered juniper, oakbrush, snowberry, and perennial grasses.

In a representative profile the surface layer is dark grayish-brown loam and silt loam about 8 inches thick. The subsoil extends to a depth of about 34 inches. The upper 21 inches is brown clay loam. The lower 5 inches is pale-brown clay loam. The substratum is pale-brown, calcareous clay loam to a depth of 60 inches.

The surface layer and subsoil are noncalcareous to moderately calcareous, and reaction is neutral to moderately alkaline. Permeability is moderately slow. The available water capacity is 8 to 11 inches. The water-supplying capacity is 10 to 12 inches annually. The effective root zone is about 5 feet.

Clegg soils are used as summer range by sheep, cattle, deer, and elk.

Representative profile of Clegg loam, 3 to 10 percent slopes, in a range area on the Gunnison Plateau, about 2,475 feet east and 250 feet north of the southwest corner of sec. 27, T. 17 S., R. 1 E., Sanpete County:

- A11—0 to 3 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) when moist; weak, thin, platy structure; soft, friable, nonsticky and plastic; common very fine roots; few very fine pores; moderately calcareous; neutral (pH 7.2); abrupt, smooth boundary.
- A12—3 to 8 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, subangular blocky structure; slightly hard, friable, slightly sticky and plastic; common very fine and few fine roots; few very fine pores; neutral (pH 7.0); clear, smooth boundary.
- B21t—8 to 22 inches, brown (10YR 5/3) clay loam, very dark grayish brown (10YR 3/2) when moist; strong, medium, angular blocky structure; very hard, very firm, sticky and plastic; few very fine and few fine roots; few very fine discontinuous pores; moderate, continuous clay films on faces of peds; few krotovinas; neutral (pH 6.8); gradual, wavy boundary.

B22t—22 to 29 inches, brown (7.5YR 5/3) clay loam, dark brown (7.5YR 3/2) when moist; weak, medium, prismatic structure parting to strong, fine, angular blocky; very hard, very firm, sticky and plastic; few very fine roots; few very fine pores; thin continuous clay films on faces of peds; moderately calcareous, lime is disseminated; moderately alkaline (pH 8.0); gradual, wavy boundary.

B3ca—29 to 34 inches, pale-brown (10YR 6/3) clay loam, dark brown (10YR 3/3) when moist; strong, fine, angular blocky structure; very hard, sticky and plastic; few very fine roots; few very fine pores; moderately calcareous, lime in fine veins and small soft rounded masses; moderately alkaline (pH 8.0); clear, smooth boundary.

Cca—34 to 60 inches, very pale brown (10YR 7/3) light clay loam, brown (10YR 5/3) when moist; massive; hard, firm, sticky and plastic; few very fine roots; few very fine pores; strongly calcareous, lime in thick veins and soft rounded masses; moderately alkaline (pH 8.0).

The soil is more than 60 inches deep.

The A horizon is 8 to 11 inches thick. It is dark grayish brown, dark brown, or very dark grayish brown when dry and very dark grayish brown or very dark brown to dark brown when moist.

The B2t horizon is brown or dark grayish brown to pale brown or light brownish gray when dry and dark brown to very dark grayish brown to very dark brown when moist. It ranges from heavy loam to clay loam and is 14 to 25 inches thick. Color above a depth of 20 inches is dark grayish brown, brown, or grayish brown when dry and very dark brown, dark brown, or very dark grayish brown when moist.

The Cca horizon is very pale brown, pale brown, pinkish white, or pink to light gray when dry and brown or grayish brown to pink or very pale brown when moist. Reaction is mildly alkaline to moderately alkaline. The Cca horizon ranges from loam to clay loam and contains 0 to 25 percent gravel and cobbles.

CNC—Clegg loam, 3 to 10 percent slopes. This soil is on alluvial fans and bottoms of small mountain valleys. It has the profile described as representative of the series. This soil frequently receives runoff from the steep mountainsides surrounding it, and rills and occasional gullies are caused by the concentration of this runoff. The water is ponded in a few places. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Deer Creek stony silt loam, high rainfall, 6 to 25 percent slopes; and Mower clay loam, 5 to 30 percent slopes.

This soil is used as summer range by sheep and cattle and by deer and elk in all seasons. A few small areas are used for nonirrigated alfalfa and grass. Capability unit IIIe-M nonirrigated; Mountain Loam range site.

Collard Series

The Collard series consists of excessively drained soils that formed in alluvium derived from sandstone and quartzite on alluvial fans. Collard soils are commonly associated with Birdow, Calita, Deer Creek, and Snake Hollow soils. Slope is 4 to 20 percent.

Elevation ranges from 5,600 to 6,100 feet. The average annual precipitation ranges from 12 to 14 inches, and the mean annual air temperature ranges from 45° to 47° F. The frost-free period is 110 to 120 days. Vegetation is big sagebrush, yellowbrush, scattered juniper, and annual weeds.

In a representative profile the surface layer is brown gravelly sandy loam about 6 inches thick. The subsoil is about 19 inches thick. The upper 5 inches is brown gravelly sandy loam. The next 9 inches is brown very gravelly light sandy clay loam. The lower 5 inches is brown very cobbly loamy sand. The substratum to a depth of about 60 inches is light-brown very cobbly loamy sand.

Collard soils are noncalcareous, and reaction is slightly acid to mildly alkaline. Permeability is rapid. The available water capacity is 2 to 4 inches. The water-supplying capacity of nonirrigated soils is about 6 inches annually. The effective root zone is 5 feet or more.

Collard soils are used mainly as range. Some small areas are used for irrigated alfalfa and pasture. These soils are a good source of road fill.

Representative profile of Collard gravelly sandy loam, 4 to 8 percent slopes, in a range area, 1½ mile north of Freedom on the west side of the Maple Canyon road, about 2,700 feet west and 480 feet north of the southeast corner of sec. 36, T. 14 S., R. 2 E., Sanpete County:

A11—0 to 2 inches, brown (7.5YR 5/3) gravelly sandy loam, dark brown (7.5YR 3/2) when moist; weak, medium, platy structure parting to weak, medium, granular; slightly hard, very friable, nonsticky and slightly plastic; few very fine roots; few very fine and fine pores; 20 percent gravel, mainly a surface mantle; neutral (pH 6.6); abrupt, smooth boundary.

A12—2 to 6 inches, brown (7.5YR 5/3) gravelly sandy loam, dark brown (7.5YR 3/2) when moist; weak, fine, subangular blocky structure; slightly hard, very friable, nonsticky and slightly plastic; few very fine and fine roots; few fine and very fine pores; 20 percent gravel; neutral (pH 6.8); clear, smooth boundary.

B1—6 to 11 inches, brown (7.5YR 5/3) gravelly sandy loam, dark brown (7.5YR 3/3) when moist; weak, medium, subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; few very fine roots; few coarse, medium, and fine pores; 35 percent gravel and cobbles; neutral (pH 6.8); clear, smooth boundary.

B2t—11 to 20 inches, brown (7.5YR 5/4) very gravelly light sandy clay loam, dark brown (7.5YR 3/3) when moist; moderate, fine, subangular blocky structure; hard, friable, slightly sticky and plastic; few fine and very fine roots; few fine and very fine pores; few thin clay films on faces of peds; 50 percent gravel and cobbles; neutral (pH 6.8); gradual, smooth boundary.

B3—20 to 25 inches, brown (7.5YR 5/4) very cobbly loamy sand, dark brown (7.5YR 4/4) when moist; single grained; loose, few fine and very fine roots; few medium pores; 60 percent gravel and cobbles; slightly acid (pH 6.4); gradual, wavy boundary.

C1—25 to 42 inches, light-brown (7.5YR 6/4) very cobbly loamy sand, brown (7.5YR 4/3) when moist; single grained; loose; few fine and very fine roots; 75 percent gravel and cobbles; neutral (pH 6.6); gradual, irregular boundary.

C2—42 to 60 inches, light-brown (7.5YR 6/4) very cobbly loamy sand, brown (7.5YR 4/3) when moist; single grained; loose; few medium, fine, and very fine roots; 75 percent gravel and cobbles; neutral (pH 6.6).

The soil is more than 60 inches deep.

The A horizon is 6 to 9 inches thick. It is brown or dark grayish brown to dark brown or grayish brown when dry and dark brown to very dark brown or very dark grayish brown when moist. It ranges from gravelly fine sandy loam to gravelly sandy loam and contains 20 to 35 percent gravel, cobbles, or stones.

The B2t horizon is brown or grayish brown to light brown, pale brown, or light yellowish brown when dry and dark brown or brown to dark yellowish brown when moist.

It ranges from gravelly sandy loam, very cobbly heavy sandy loam, or gravelly sandy clay loam to very cobbly sandy clay loam. Content of rock fragments ranges from 35 to 70 percent.

The C horizon is light brown, reddish brown, brown, yellowish brown, light reddish brown, or light yellowish brown when dry and brown, dark brown, dark grayish brown, grayish brown, yellowish brown, or dark yellowish brown when moist. The C horizon ranges from very gravelly or very cobbly sandy loam to very cobbly loamy sand. Content of coarse fragments ranges from 50 to 80 percent.

CoC—Collard gravelly sandy loam, 4 to 8 percent slopes. This soil is on alluvial fans (fig. 3). It has the



Figure 3.—Collard gravelly sandy loam, 4 to 8 percent slopes. Depth is marked in feet.

profile described as representative of the series. Runoff is medium, and the hazard of erosion is slight. In places about 2 percent of the surface is covered by cobbles and stones.

Included with this soil in mapping are small areas of Collard stony sandy loam, 4 to 20 percent slopes; Snake Hollow gravelly fine sandy loam, 2 to 4 percent slopes; and Deer Creek stony silt loam, 6 to 30 percent slopes.

This soil is used mainly as range. Small areas are used for irrigated alfalfa and pasture. This soil is a good source of road fill. Capability units IVs-24 irrigated, VIs-U nonirrigated; Upland Stony Loam range site.

CRD—Collard stony sandy loam, 4 to 20 percent slopes. This soil is on alluvial fans. It has a profile similar to the one described as representative of the series, but stones cover 2 to 10 percent of the surface. About 10 percent of the area mapped, mainly on the ridges, has 10 to 25 percent of the surface covered by stones and cobbles. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Collard gravelly sandy loam, 4 to 8 percent slopes; Snake Hollow gravelly fine sandy loam, 2 to 4 percent slopes; and Deer Creek stony silt loam, 6 to 30 percent slopes.

This soil is used as spring and fall range by sheep and cattle and as winter range by deer. It is a good source of road fill. Capability unit VIs-U nonirrigated; Upland Stony Loam (Juniper-Pinon) range site.

Crestline Series

The Crestline series consists of well-drained soils that formed in alluvium derived from sandstone, basalt, and laterite on alluvial fans and flood plains. Crestline soils are most commonly associated with Arapien, Genola, Sanpete, and Woodrow soils. Slopes are typically smooth and are 2 to 5 percent.

Elevation ranges from 5,200 to 5,600 feet. The average annual precipitation ranges from 8 to 12 inches, and the mean annual air temperature ranges from 45° to 49° F. The frost-free period is 110 to 130 days. Vegetation in the noncultivated areas is dominantly big sagebrush, black sagebrush, cheatgrass, and annual weeds.

In a representative profile the surface layer is light brownish-gray sandy loam about 3 inches thick. The subsoil is about 16 inches thick. It is light brownish-gray heavy loam in the upper part and pale-brown sandy clay loam in the lower part. The substratum is pale-brown sandy loam to a depth of about 27 inches and light-gray loamy sand to a depth of 60 inches.

Crestline soils are slightly calcareous to moderately calcareous, and reaction is strongly alkaline throughout. Permeability is moderately rapid. The available water capacity is 5 to 7½ inches. The water-supplying capacity of nonirrigated soils is 5 to 8 inches annually. The effective root zone is 5 feet or more.

Crestline soils are used as range.

Representative profile of Crestline fine sandy loam, 2 to 5 percent slopes, in a range area north of Fayette near the Sanpete-Juab County line, 1 mile west of

Highway U-28, about 2,013 feet west, 122 feet south of the northeast corner of sec. 5, T. 17 S., R. 1 W., Sanpete County:

- A1—0 to 3 inches, light brownish-gray (10YR 6/2) sandy loam, dark grayish brown (10YR 4/2) when moist; moderate, fine, granular structure; slightly hard, firm, sticky and plastic; common fine roots; slightly calcareous; strongly alkaline (pH 8.6); clear, smooth boundary.
- B21—3 to 11 inches, light brownish-gray (10YR 6/2) heavy loam, dark grayish brown (10YR 4/2) when moist; weak, fine, subangular blocky structure; hard, firm, sticky and plastic; common fine and few medium roots; slightly calcareous; strongly alkaline (pH 8.6); gradual, smooth boundary.
- B22—11 to 19 inches, pale-brown (10YR 6/3) sandy clay loam, dark grayish brown (10YR 4/2) when moist; weak, fine, subangular blocky structure parting to moderate, fine, granular; hard, firm, sticky and very plastic; few fine roots; moderately calcareous; strongly alkaline (pH 8.7); gradual, smooth boundary.
- C1—19 to 27 inches, pale-brown (10YR 6/3) sandy loam, dark grayish brown (10YR 4/2) when moist; massive; hard, friable, sticky and slightly plastic; few fine roots; moderately calcareous; strongly alkaline (pH 8.9); gradual, smooth boundary.
- C2—27 to 42 inches, light-gray (10YR 7/2) loamy sand, light brownish gray (10YR 6/2) when moist; massive; loose, friable, nonsticky and nonplastic; few fine roots; moderately calcareous; strongly alkaline (pH 9.0); gradual, smooth boundary.
- C3—42 to 62 inches, light-gray (10YR 7/2) loamy sand, grayish brown (10YR 5/2) when moist; single grained; loose; moderately calcareous; strongly alkaline (pH 9.0).

Coarse fragments, mainly gravel, make up as much as 30 percent of the soil, but average about 20 percent.

The A horizon is 3 to 5 inches thick. It is light brownish gray to grayish brown when dry and dark grayish brown when moist.

The B2 horizon is light brownish gray, grayish brown, or pale brown when dry and dark grayish brown when moist. It is heavy loam or sandy clay loam 11 to 16 inches thick.

The C horizon is pale brown, light brown, pink, or light gray or very pale brown when dry and brown, light brownish gray, dark grayish brown, or grayish brown when moist. The C horizon ranges from fine sandy loam or gravelly fine sandy loam to loamy sand or gravelly loamy sand. At depths below 40 inches gravel content ranges to as much as 35 percent but averages about 20 percent.

CsC—Crestline fine sandy loam, 2 to 5 percent slopes. This soil is on alluvial fans and flood plains. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Arapien fine sandy loam, 2 to 5 percent slopes, eroded, and Genola loam, 2 to 5 percent slopes, eroded.

Successful crested wheatgrass seedings have been made on this soil during years of above-average precipitation.

This soil is used as spring and fall range mainly by sheep. Capability unit V1e-S nonirrigated; Semi-desert Loam range site.

Cryoborolls

CU—Cryoborolls consist of recent colluvial soil material, rock fragments, and gravel or cobbles. The landscape is typically hummocky with small hills and pockets. The surface layer has been darkened by organic matter, but little other soil development has taken place. Slopes range from 10 to 70 percent. These

soils are well drained. They are commonly associated with Daybell, Cheadle, Pritchett, and Skylick soils.

Elevation ranges from 7,000 to 9,000 feet. The average annual precipitation ranges from 16 to 25 inches, and the mean annual air temperature ranges from 40° to 45° F. The frost-free period is 80 to 90 days. Vegetation is scattered aspen, snowberry, oakbrush, and perennial grasses. Capability unit V1e-H nonirrigated; High Mountain Stony Loam (Aspen) range site.

Daybell Series

The Daybell series consists of somewhat excessively drained soils that formed in colluvium derived from sandstone on mountainsides. Daybell soils are commonly associated with Adel, Bradshaw, Cheadle, and Flygare soils. Slope is 40 to 70 percent.

Elevation ranges from 7,000 to 9,000 feet. The average annual precipitation ranges from 20 to 30 inches, and the mean annual air temperature ranges from 40° to 43° F. The frost-free period is 80 to 90 days. Vegetation is aspen, mountain brome, ninebark, peavine, and snowberry.

In a representative profile the surface layer is very dark grayish-brown and dark grayish-brown gravelly silt loam about 22 inches thick. The substratum to a depth of 60 inches is pale-brown and light yellowish-brown very gravelly very fine sandy loam and fine sandy loam.

Reaction is medium acid to neutral. Permeability is rapid. The available water capacity is 3 to 6 inches. The water-supplying capacity is 11 to 13 inches annually. The effective root zone is 5 feet or more.

Daybell soils are used as summer range by sheep, cattle, deer, and elk. They are also used as woodland. These soils are a good source of road fill.

Representative profile of Daybell gravelly silt loam, 40 to 70 percent slopes, in a range woodland area, about 1½ miles below the microwave relay tower on the jeep road between the Dream mine and the tower, about 500 feet south and 500 feet east of the northwest corner of sec. 22, T. 9 S., R. 3 E., Utah County:

- A11—0 to 6 inches, very dark grayish-brown (10YR 3/2) gravelly silt loam, very dark brown (10YR 2/2) when moist; weak, fine, granular structure; soft, friable, nonsticky and slightly plastic; many very fine, few medium roots; 20 percent gravel; slightly acid (pH 6.5); gradual, smooth boundary.
- A12—6 to 15 inches, very dark grayish-brown (10YR 3/2) gravelly silt loam, very dark brown (10YR 2/2) when moist; weak, medium, subangular blocky structure parting to weak, fine, granular; soft, friable, non-sticky and slightly plastic; many very fine, few fine and medium roots; common fine interstitial pores; 30 percent gravel; slightly acid (pH 6.4); clear, smooth boundary.
- A13—15 to 22 inches, dark grayish-brown (10YR 4/2) gravelly silt loam, very dark brown (10YR 2/2) when moist; weak, fine, subangular blocky structure; slightly hard, friable, slightly sticky and plastic; many very fine, few fine and medium roots; common fine pores; 40 percent angular gravel; slightly acid (pH 6.3); clear, wavy boundary.
- C1—22 to 34 inches, pale-brown (10YR 6/3) very gravelly very fine sandy loam, dark brown (10YR 4/3) when moist; massive; soft, friable, slightly sticky and plastic; few medium roots; interstices not filled; 40 percent gravel, 30 percent cobbles, and 10 percent stones; medium acid (pH 6.0); gradual, smooth boundary.

C2—34 to 43 inches, light yellowish-brown (10YR 6/4) very gravelly very fine sandy loam; dark brown (10YR 4/3) when moist; massive; soft, friable, slightly sticky and slightly plastic; few medium, large, and fine roots; interstices not filled; few thin clay films on coarse fragments; 35 percent gravel, 25 percent cobbles, and 10 percent stones; medium acid (pH 6.0); gradual, smooth boundary.

C3—43 to 60 inches, pale-brown (10YR 6/3) very gravelly fine sandy loam, dark brown (10YR 3/3) when moist; massive; soft, very friable, nonsticky and slightly plastic; 35 percent gravel, 35 percent cobbles, 10 percent stones; medium acid (pH 6.0).

The soil is 60 inches or more deep. Between depths of 10 and 40 inches, it ranges from gravelly or cobbly silt loam, very fine sandy loam, or fine sandy loam to very gravelly or very cobbly silt loam, very fine sandy loam, or fine sandy loam. Content of rock fragments ranges from 30 to 80 percent.

The A horizon is 16 to 24 inches thick. It is very dark grayish brown, dark grayish brown, or dark brown to brown or grayish brown when dry and very dark brown or dark brown to very dark grayish brown when moist. The A horizon ranges from gravelly very fine sandy loam to gravelly silt loam, and content of gravel and cobbles is 20 to 50 percent.

The C horizon is light brown, pale brown, or light yellowish brown to pink or very pale brown when dry and dark brown or dark grayish brown to brown or yellowish brown when moist. Content of stones typically increases below a depth of 40 inches.

DAG—Daybell gravelly silt loam, 40 to 70 percent slopes. This soil is on northern exposures of mountain-sides. It has the profile described as representative of the series (fig. 4). Runoff is medium, and the hazard of erosion is moderate. In places stones cover about 2 percent of the surface.

Included with this soil in mapping are small areas of Daybell soil, 70 to 80 percent slopes; Bradshaw very stony loam, 60 to 80 percent slopes; and Flygare gravelly silt loam, 50 to 80 percent slopes. Also included are areas of Rock outcrop.

This soil is used as summer range by sheep, cattle, deer, and elk. Although it is very steep, it is a good source of road fill. This soil is well suited to aspen woodland, and has a site index of about 76 for aspen. The average annual production is about 35 cubic feet of cordwood or 64 board feet of sawtimber per acre. Windthrow hazard is slight; plant competition and seedling mortality are moderate; equipment restriction is severe. Capability unit VIIe-H nonirrigated; High Mountain Stony Loam (Aspen) range site.

DBG—Daybell-Flygare association, very steep. This mapping unit is on the northern exposures of mountainsides. It is about 55 percent Daybell gravelly silt loam, 40 to 70 percent slopes, on the broad side slopes and about 30 percent Flygare gravelly silt loam, 50 to 80 percent slopes, in the small canyons, swales, and pockets. The rest is small areas of Cheadle very flaggy silt loam, 40 to 70 percent slopes; small areas that have 2 to 10 percent of the surface covered by stones; small areas of a soil that has a thick bleached sub-surface layer; and about 5 percent Rock outcrop.

Runoff is medium on the Daybell soils, and the hazard of erosion is moderate. Runoff is slow on the Flygare soils, and the hazard of erosion is moderate.

The Daybell soil is used as summer range mainly by deer and elk. The Flygare soil is used for woodland of fir and spruce.



Figure 4.—Daybell gravelly silt loam, 40 to 70 percent slopes. Depth is marked in feet.

Vegetation on the Daybell gravelly silt loam is aspen, mountain brome, ninebark, western coneflower, peavine, and snowberry. This soil has a site index of about 76 for aspen. The average annual production is about 35 cubic feet of cordwood or 64 board feet of sawtimber per acre. Windthrow hazard is slight; plant competition and seedling mortality are moderate; equipment restriction is severe.

Vegetation on the Flygare gravelly silt loam is chiefly alpine fir and Engelmann spruce. The site index for Engelmann spruce is about 47 and for alpine fir is about 65. The average annual production is about 90 board feet of sawtimber per acre for both species. Windthrow hazard, plant competition, and seedling mortality are slight; equipment restriction is severe.

Daybell soil in capability unit VIIe-H nonirrigated, High Mountain Stony Loam (Aspen) range site; Flygare soil in capability unit VIIs-HC nonirrigated, range site not assigned.

Deer Creek Series

The Deer Creek series consists of well-drained soils that formed in alluvium and colluvium derived from sandstone, limestone, quartzite, and mixed igneous rocks on mountainsides. Deer Creek soils are commonly associated with Ant Flat, Fontreen, Lizzant, Manila, and Mower soils. Slope is 6 to 40 percent.

Elevation ranges from 6,500 to 7,500 feet. The average annual precipitation ranges from 14 to 20 inches, and the mean annual air temperature ranges from 40° to 45° F. The frost-free period is 80 to 100 days. Vegetation is big sagebrush, oakbrush, perennial grasses, and snowberry.

In a representative profile the surface layer is about 10 inches thick. It is dark-brown stony silt loam in the upper 2 inches and very dark grayish-brown and dark grayish-brown silt loam and silty clay loam below. The subsoil is about 24 inches thick. It is brown stony and cobbly clay in the upper 18 inches and light yellowish-brown cobby clay loam in the lower 6 inches. The substratum is very pale brown cobbly clay loam and cobbly silty clay loam to a depth of 60 inches or more.

The subsoil is noncalcareous, and the substratum is very strongly calcareous and strongly calcareous. Reaction is slightly acid to neutral in the surface layer, neutral to mildly alkaline in the subsoil, and mildly alkaline to strongly alkaline in the substratum. Permeability is slow. The available water capacity is 6 to 9 inches. The water-supplying capacity is 10 to 14 inches annually. The effective root zone is about 5 feet.

Deer Creek soils are used as range by cattle and sheep in summer and fall and by deer and elk in winter.

Representative profile of Deer Creek stony silt loam, high rainfall, 25 to 40 percent slopes, in a range area, at the mouth of Pleasant Creek Canyon along the road to the television tower, 2,500 feet east and 1,650 feet north of the southwest corner of sec. 5, T. 15 S., R. 5 E., Sanpete County:

- A11—0 to 2 inches, dark-brown (10YR 3/3) stony silt loam, very dark brown (10YR 2/2) when moist; moderate, fine, granular structure; slightly hard, friable, slightly sticky and plastic; many very fine roots; few very fine pores; slightly acid (pH 6.5); abrupt, smooth boundary.
- A12—2 to 7 inches, very dark grayish-brown (10YR 3/2) heavy silt loam, very dark brown (10YR 2/2) when moist; moderate, medium, granular structure; slightly hard, friable, slightly sticky and plastic; many very fine, few fine and coarse roots; few fine pores; neutral (pH 6.6); clear, smooth boundary.
- A13—7 to 10 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) when moist; moderate, medium, subangular blocky structure; hard,

firm, sticky and plastic; few very fine and common fine roots; few fine pores; slightly acid (pH 6.4); abrupt, wavy boundary.

B21t—10 to 19 inches, brown (7.5YR 5/4) stony clay, dark brown (7.5YR 4/4) when moist; strong, medium, angular blocky structure; extremely hard, very firm, very sticky and very plastic; few coarse, few fine and very fine roots; few very fine pores; common moderately thick clay films; 20 percent stones; neutral (pH 7.3); diffused, smooth boundary.

B22t—19 to 28 inches, brown (7.5YR 5/4) cobbly clay, dark brown (7.5YR 4/4) when moist; weak, coarse, prismatic structure parting to strong, medium, angular blocky; extremely hard, very fine, very sticky and very plastic; few fine, medium, and coarse roots; few fine pores; common moderately thick clay films; 20 percent cobbles and stones; mildly alkaline (pH 7.6); abrupt, smooth boundary.

B3ca—28 to 34 inches, light yellowish-brown (10YR 6/4) cobbly clay loam, brown (7.5YR 5/4) when moist; moderate, medium, angular blocky structure; very hard, very firm, sticky and plastic; few medium and coarse roots; few fine pores; 20 percent cobbles and stones; strongly calcareous, lime in fine soft rounded masses; strongly alkaline (pH 8.6); gradual, smooth boundary.

C1ca—34 to 50 inches, very pale brown (10YR 7/3) cobbly clay loam, brown (10YR 5/3) when moist; massive; very hard, very firm, sticky and plastic; few coarse medium and fine roots; few very fine and fine pores; 20 percent cobbles and stones, some saprolitic limestone; very strongly calcareous, lime in soft rounded masses; strongly alkaline (pH 8.8); gradual, wavy boundary.

C2—50 to 60 inches, very pale brown (10YR 7/3) cobbly silty clay loam, brown (10YR 5/3) when moist; massive; hard, firm, sticky and plastic; few very fine and fine roots; few very fine pores; 20 percent cobbles and stones; strongly calcareous, lime in veins and soft rounded masses; strongly alkaline (pH 9.0).

The A horizon is 8 to 13 inches thick and ranges from stony silt loam to silt loam, loam, or light silty clay loam. It is very dark grayish brown, dark grayish brown, or dark brown to brown or grayish brown when dry and very dark brown to dark brown or very dark grayish brown when moist.

The B2t horizon is 14 to 30 inches thick. It is brown, dark brown, or reddish brown to light reddish brown or light brown when dry and dark brown or dark reddish brown to brown or reddish brown when moist. The B2t horizon ranges from silty clay to clay and has 20 to 35 percent cobbles or stones.

The Cca horizon is very pale brown, light brown, pale brown, light yellowish brown, or pink when dry and brown, dark brown, dark grayish brown, pale brown, light brown, or light yellowish brown when moist. It ranges from gravelly sandy loam to very cobbly clay loam. Lime content ranges from 30 to 65 percent.

DCD—Deer Creek stony silt loam, 6 to 30 percent slopes. This soil is on mountainsides. The average annual precipitation is about 14 inches. Stones and cobbles cover 2 to 10 percent of the surface. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Ant Flat loam, low rainfall, 4 to 8 percent slopes, and Sanpitch very stony loam, 8 to 40 percent slopes.

This soil is used as spring and fall range by sheep, cattle, and deer. Capability unit VIe-U nonirrigated; Upland Loam range site.

DED—Deer Creek stony silt loam, high rainfall, 6 to 25 percent slopes. This soil is on mountainsides (fig. 5). The average annual precipitation ranges from 16 to 20 inches. Stones and cobbles cover 2 to 10 percent of the surface. Runoff is medium, and the hazard of erosion is moderate.

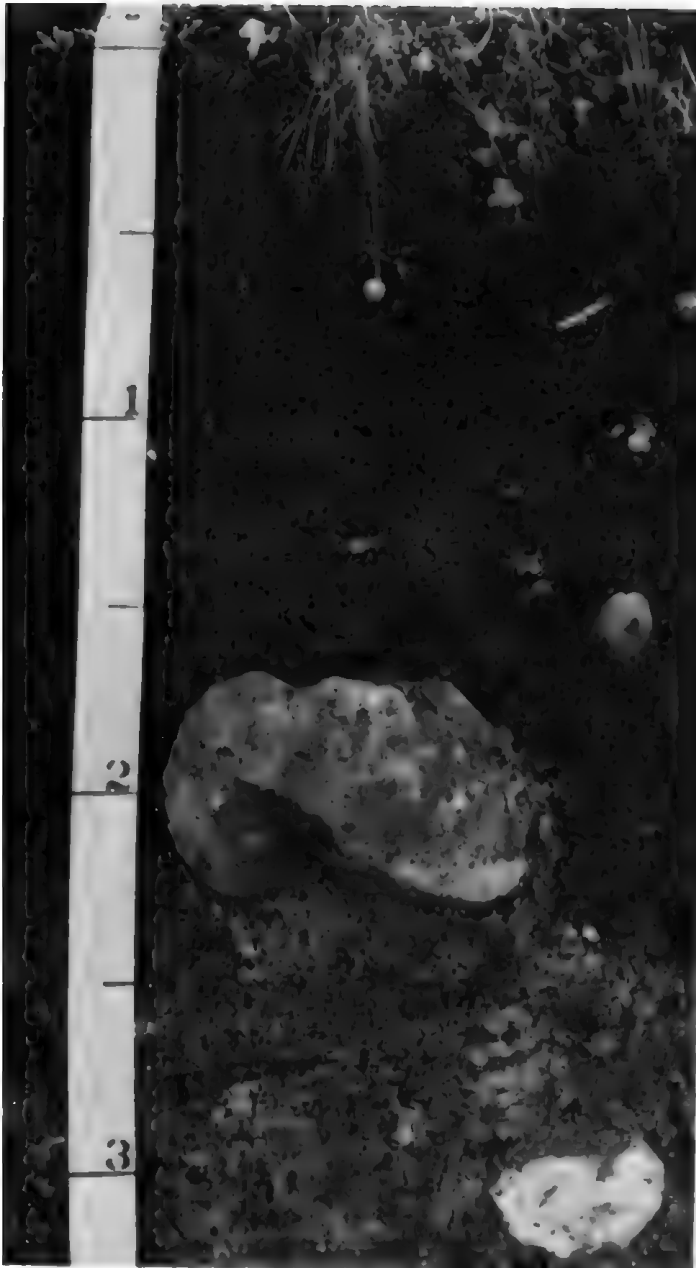


Figure 5.—Deer Creek stony silt loam. The light-colored underlying layer contains accumulated lime. Depth is marked in feet.

Included with this soil in mapping are small areas of Mower clay loam, 5 to 30 percent slopes; Ant Flat stony loam, 8 to 25 percent slopes; and Obrast silty clay, 4 to 25 percent slopes.

This soil is used as range by sheep, cattle, and deer. Capability unit VIe-M; Mountain Loam (Oak) range site.

DEE—Deer Creek stony silt loam, high rainfall, 25 to 40 percent slopes. This soil is on mountainsides. It has the profile described as representative of the series. The average annual precipitation ranges from about

16 to 20 inches. Stones and cobbles cover 2 to 10 percent of the surface. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Ant Flat stony loam, 25 to 40 percent slopes, eroded; Obrast silty clay, 4 to 25 percent slopes, in the swales; and Mower clay loam, 5 to 30 percent slopes.

This soil is used as summer range by sheep, cattle, and deer. Capability unit VIe-M nonirrigated; Mountain Loam (Oak) range site.

DFF—Deer Creek-Mower complex, 25 to 50 percent slopes. This mapping unit is on mountainsides and on foothills. It is about 60 percent Deer Creek stony silt loam, high rainfall, 25 to 40 percent slopes, on northern exposures and in swales and pockets; about 30 percent Mower very stony loam, 25 to 50 percent slopes, eroded, on points and ridges; about 5 percent Ant Flat stony loam, 8 to 25 percent slopes, in swales; and 5 percent Atepic very cobbly silty clay loam, 8 to 40 percent slopes.

Runoff is medium on the Deer Creek soils, and the hazard of erosion is moderate. Mower very stony loam, 25 to 50 percent slopes, eroded, has a profile similar to the one described as representative of the Mower series, but stones and cobbles cover 10 to 25 percent of the surface, and the surface layer is stony loam or stony silt loam. Runoff is medium, and the hazard of erosion is severe. Vegetation is mainly manzanita.

This mapping unit is used as summer range by sheep, cattle, and deer. Capability unit VIe-M nonirrigated; Deer Creek soil in Mountain Loam (Oak) range site, Mower soil in Mountain Shallow Loam range site.

Denmark Series

The Denmark series consists of somewhat excessively drained soils less than 20 inches deep over a lime-cemented, indurated hardpan. These soils formed in alluvium derived from limestone and sandstone on rolling hills. Denmark soils are commonly associated with Arapien, Freedom, and Lisade soils. Slope is 2 to 5 percent.

Elevation ranges from 5,100 to 5,600 feet. The average annual precipitation ranges from 8 to 12 inches, and the mean annual air temperature ranges from 45° to 49° F. The frost-free period is 100 to 120 days. Vegetation is dominantly big sagebrush, perennial grasses, and cheatgrass.

In a representative profile the surface layer is light-brown loam and gravelly loam about 8 inches thick. The substratum is about 10 inches of pink and pinkish-white gravelly loam underlain by a lime-cemented indurated hardpan at a depth of about 18 inches.

Denmark soils are very strongly calcareous, and reaction is moderately alkaline to strongly alkaline. Permeability is moderately rapid about the hardpan and very slow in the hardpan. The available water capacity is 2 to 3 inches. The water-supplying capacity is less than 4 inches annually. Roots penetrate to the top of the hardpan, or a depth of 10 to 20 inches.

Denmark soils are used as range and as habitat by upland game birds and small game. They are also a source of road fill below a depth of about 20 inches.

Representative profile of Denmark gravelly loam, 2 to 5 percent slopes, in a range area 3 miles southeast of Moroni, about 1,530 feet west and 714 feet south of the northeast corner of sec. 24, T. 15 S., R. 3 E., Sanpete County:

A11—0 to 3 inches, light-brown (7.5YR 6/3) loam, brown (7.5YR 5/3) when moist; weak, fine, granular structure; slightly hard, friable, slightly sticky and plastic; common very fine roots; very strongly calcareous, lime in hardpan fragments; strongly alkaline (pH 8.6); abrupt, smooth boundary.

A12—3 to 8 inches, light-brown (7.5YR 6/3) gravelly loam, brown (7.5YR 5/4) when moist; weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky and plastic; common fine and very fine roots; very strongly calcareous, lime in fine hardpan fragments; strongly alkaline (pH 8.6); gradual, smooth boundary.

C1ca—8 to 11 inches, pink (7.5YR 7/4) gravelly loam, brown (7.5YR 5/4) when moist; massive; slightly hard, friable, slightly sticky and plastic; 20 percent hardpan fragments and gravel; very strongly calcareous, lime in soft rounded masses; strongly alkaline (pH 8.8); gradual, smooth boundary.

C2ca—11 to 18 inches, pinkish-white (7.5YR 8/2) gravelly loam, pinkish gray (7.5YR 7/2) when moist; massive; slightly hard, friable, slightly sticky and plastic; few very fine roots; few very fine pores; 20 percent gravel and hardpan fragments; very strongly calcareous, lime in soft rounded masses; strongly alkaline (pH 9.0); abrupt, smooth boundary.

C3cam—18 to 32 inches, pinkish-white (7.5YR 8/2) indurated hardpan that has distinct laminations; no visible roots.

Depth to the indurated lime-cemented hardpan ranges from 10 to 20 inches but is dominantly about 18 inches. Texture between depths of 10 and 20 inches is gravelly loam. Content of gravel and hardpan fragments is 10 to 35 percent.

The A horizon is 5 to 10 inches thick. It is light brown to pink or very pale brown when dry and dark brown to brown or grayish brown when moist.

The Cca horizon is light brown to pink, very pale brown, pinkish white, or pinkish gray when dry and pinkish gray, brown, grayish brown, pale brown, or light brownish gray when moist.

DgC—Denmark gravelly loam, 2 to 5 percent slopes. This soil is on rolling hills. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Arapien fine sandy loam, 2 to 5 percent slopes, eroded, and Freedom silt loam, 2 to 10 percent slopes.

This soil is used as spring and fall range by sheep and cattle. It is also a fair source of road fill. Capability unit VIIs-S nonirrigated; Semi-desert Shallow Loam range site.

Donnardo Series

The Donnardo series consists of somewhat excessively drained soils that formed in alluvium derived from sandstone, shale, and limestone on alluvial fans and alluvial plains. Donnardo soils are commonly associated with Birdow, Borvant, Doyce, Mountainville, and Pavant soils. Slope is 4 to 16 percent.

Elevation ranges from 5,400 to 6,200 feet. The average annual precipitation ranges from 12 to 14 inches, and the mean annual air temperature ranges

from 45° to 47° F. The frost-free period is 100 to 120 days. Vegetation is big sagebrush, cliffrose, perennial grasses, juniper, pinon, and oakbrush.

In a representative profile the surface layer is dark-brown and brown very stony loam and cobbly loam about 15 inches thick. The substratum is very pale brown strongly calcareous very stony loam to a depth of about 30 inches and pale-brown and pale-yellow very stony loam to a depth of 60 inches.

Permeability is rapid. The available water capacity is 4 to 6 inches. The water-supplying capacity of non-irrigated soils is 6 to 8 inches annually. Roots extend to a depth of 60 inches or more.

Donnardo soils are used as spring and fall range by sheep, cattle, and deer. These soils are also a source of road fill.

Representative profile of Donnardo very stony loam, 4 to 16 percent slopes, in a range area, about 3 miles east of Spring City, about 2,970 feet due east of the southwest corner of sec. 35, T. 15 S., R. 4 E., Sanpete County:

A11—0 to 2 inches, dark-brown (10YR 4/3) very stony loam, very dark brown (10YR 2/2) when moist; moderate, medium, granular structure; slightly hard, friable, nonsticky and slightly plastic; many very fine and few fine roots; common fine pores; stones cover 10 to 25 percent of the surface; slightly calcareous; mildly alkaline (pH 7.4); abrupt, smooth boundary.

A12—2 to 10 inches, brown (10YR 5/3) very stony loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine and medium roots; common fine and medium pores; 50 percent rock fragments, dominantly stones and cobbles; slightly calcareous; mildly alkaline (pH 7.6); gradual, smooth boundary.

A13—10 to 15 inches, brown (10YR 5/3) cobbly loam, dark brown (10YR 3/3) when moist; moderate, medium and fine, subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few medium and fine roots; common medium and few fine pores; 45 percent cobbles and gravel; moderately calcareous; moderately alkaline (pH 8.0); gradual, wavy boundary.

C1ca—15 to 30 inches, very pale brown (10YR 7/3) very stony heavy loam, brown (10YR 4/3) when moist; moderate, medium, subangular blocky structure; hard, friable, slightly sticky and plastic; few medium and fine roots; few medium and common fine pores; common krotovinas; 50 percent rock fragments, dominantly stones and cobbles; strongly calcareous, lime in veins and fine soft rounded masses; strongly alkaline (pH 8.6); clear, wavy boundary.

C2—30 to 41 inches, pale-brown (10YR 6/3) very stony heavy loam, dark brown (10YR 4/3) when moist; weak, medium, subangular blocky structure; slightly hard, friable, sticky and plastic; few medium and fine roots; common medium and fine pores; 60 percent rock fragments, dominantly cobbles and stones; strongly calcareous, lime in fine veins; strongly alkaline (pH 8.6); clear, wavy boundary.

C3—41 to 60 inches, pale-yellow (2.5Y 7/3) very stony loam, light olive brown (2.5Y 5/3) when moist; massive; hard, friable, slightly sticky and plastic; few fine and very fine roots; few fine and common very fine pores; 70 percent rock fragments, dominantly stones; strongly calcareous; strongly alkaline (pH 8.6).

Texture between depths of 10 and 40 inches ranges from cobbly or very cobbly loam to cobbly or very cobbly sandy loam and stony or very stony loam to stony or very stony sandy loam. Content of rock fragments ranges from 35 to 70 percent and is mainly cobbles and stones.

The A horizon is 8 to 19 inches thick. It ranges from dark brown or grayish brown to brown when dry and very dark grayish brown or very dark brown to dark brown,

when moist. The A horizon is slightly calcareous to strongly calcareous, and reaction is mildly alkaline to moderately alkaline.

The Cca horizon is 12 to 20 inches thick. It is light brown, pale brown, pink, or very pale brown when dry and dark brown, brown, dark grayish brown, light brown, pale brown, or light yellowish brown when moist. Reaction is moderately alkaline to strongly alkaline.

The C horizon is pale brown, light brown, or light yellowish brown to pink, very pale brown, or pale yellow when dry and brown, dark brown, light olive brown, or grayish brown when moist. Reaction is moderately alkaline to strongly alkaline.

DhD—Donnardo cobbly loam, 4 to 16 percent slopes. This soil is on alluvial fans and alluvial plains. It has a profile similar to the one described as representative of the series, but the rock fragments on the surface and in the substratum are mainly cobbles. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Donnardo very stony loam, 4 to 16 percent slopes; Pavant loam, 4 to 8 percent slopes; and Doyce loam, 4 to 8 percent slopes.

This soil is used as spring and fall range by sheep, cattle, and deer. It is a fair source of road fill. Capability unit VIIs-U nonirrigated; Upland Stony Loam range site.

DKD—Donnardo very stony loam, 4 to 16 percent slopes. This soil is on alluvial fans and alluvial plains. It has the profile described as representative of the series. Slope is 4 to 16 percent. Runoff is medium, and the hazard of erosion is moderate. Sheet erosion is moderate, and there are rills and deep gullies in the bottoms of drainageways.

Included with this soil in mapping are small areas of Mountainville very stony sandy loam, 2 to 8 percent slopes; Pavant loam, 4 to 8 percent slopes; and Fontreen cobbly loam, 4 to 20 percent slopes.

This soil is used as spring and fall range by sheep and cattle and as winter range by deer. It is a fair source of road fill. Capability unit VIIs-U nonirrigated; Upland Stony Loam (Juniper-Pinon) range site.

DLB—Donnardo bouldery loam, 4 to 16 percent slopes. This soil is on alluvial fans and alluvial plains. It has a profile similar to the one described as representative of the series, but boulders that range from 3 to 25 feet in diameter cover about 2 percent of the surface. There are also stones and cobbles on the surface. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Sanpete stony fine sandy loam, 5 to 30 percent slopes, eroded; Donnardo very stony loam, 4 to 16 percent slopes; and a Calita loam soil that has cobbles and stones on the surface.

This soil is used as spring and fall range by sheep and cattle, and as winter range by deer. Capability unit VIIs-U nonirrigated; Upland Stony Loam range site.

Doyce Series

The Doyce series consists of well drained and moderately well drained soils that formed in alluvium derived from sandstone and minor amounts of limestone and shale on alluvial fans. Doyce soils are commonly associated with Birdow, Borvant, Collard, Don-

nardo, and Mountainville soils. Slope is 2 to 8 percent.

Elevation ranges from 5,600 to 6,100 feet. The average annual precipitation ranges from 11 to 13 inches, and the mean annual air temperature ranges from 45° to 47° F. The frost-free period is 100 to 120 days. Vegetation is big sagebrush, scattered juniper, bitterbrush, and perennial grasses.

In a representative profile the surface layer is dark-brown and brown loam about 10 inches thick. The subsoil is brown and light-brown sandy clay loam about 10 inches thick. The substratum is light-brown and pink sandy clay loam, stony sandy clay loam, loam, and stony loam to a depth of about 60 inches.

The surface layer and subsoil of the Doyce soils are noncalcareous to moderately calcareous, and reaction is neutral to moderately alkaline. The substratum is strongly calcareous to very strongly calcareous, and reaction is moderately alkaline to strongly alkaline. Permeability is moderately slow. The available water capacity is 7 to 10 inches. The water-supplying capacity of nonirrigated soils is 8 or 9 inches annually. The effective root zone is 60 inches or more. A seasonal high water table is below a depth of 40 inches.

Doyce soils are used for irrigated alfalfa, small grain, and pasture. They are also used for nonirrigated alfalfa and pasture but are not suited to nonirrigated small grain because precipitation is low. Small areas are used as range.

Representative profile of Doyce loam, 2 to 4 percent slopes, in a range area in the Denmark Cedars southeast of Spring City, about 1,650 feet north and 250 feet east of the southwest corner of sec. 8, T. 16 S., R. 4 E., Sanpete County:

A11—0 to 2 inches, dark-brown (7.5YR 4/3) light loam, dark brown (7.5YR 3/3) when moist; moderate, thin, platy structure; slightly hard, very friable, nonsticky and slightly plastic; many very fine roots; few very fine pores; noncalcareous; mildly alkaline (pH 7.8); abrupt, smooth boundary.

A12—2 to 10 inches, brown (7.5YR 5/3) loam, dark brown (7.5YR 3/3) when moist; weak, medium, platy structure in upper 3 inches and weak, fine, subangular blocky in lower 5 inches; slightly hard, friable, slightly sticky and plastic; common very fine roots; common fine pores; noncalcareous; mildly alkaline (pH 7.8); clear, smooth boundary.

B2t—10 to 16 inches, brown (7.5YR 5/3) sandy clay loam, dark brown (7.5YR 4/3) when moist; strong, medium, angular blocky structure; very hard, firm, sticky and plastic; few very fine roots; few very fine pores; few thin clay films in pores and on peds; moderately calcareous; moderately alkaline (pH 8.0); clear, smooth boundary.

B3tca—16 to 20 inches, light-brown (7.5YR 6/4) sandy clay loam, dark brown (7.5YR 4/4) when moist; moderate, medium, angular blocky structure; very hard, firm, sticky and plastic; few very fine roots; few very fine and coarse pores; few thin clay films mainly in pores; moderately calcareous, lime in fine veins or soft rounded masses; moderately alkaline (pH 8.4); clear, smooth boundary.

C1ca—20 to 32 inches, light-brown (7.5YR 6/4) sandy clay loam, dark brown (7.5YR 4/3) when moist; massive; very hard, firm, slightly sticky and plastic; few fine and very fine roots; few very fine pores; 10 percent gravel; strongly calcareous, lime in fine veins, few fine nodules, and segregated on rock fragments; strongly alkaline (pH 8.6); gradual, wavy boundary.

C2ca—32 to 44 inches, light-brown (7.5YR 6/3) stony light sandy clay loam, dark brown (7.5YR 4/3) when moist; massive; very hard, firm, sticky and plastic; few

fine and very fine roots; few very fine pores; 35 percent cobbles and stones; strongly calcareous, lime in veins and ¼-inch coatings on rock fragments; strongly alkaline (pH 8.5); gradual, wavy boundary.

C3—44 to 48 inches, pink (7.5YR 7/3) loam, brown (7.5YR 5/3) when moist; massive and very compacted; extremely hard, friable, nonsticky and nonplastic; few very fine discontinuous pores; strongly calcareous, lime in fine nodules; strongly alkaline (pH 8.8); abrupt, smooth boundary.

C4cab—48 to 60 inches, pink (7.5 YR 8/3) stony loam, light brown (7.5YR 6/3) when moist; massive; very hard, friable, slightly sticky and plastic; common very fine pores; 25 percent stones; very strongly calcareous, lime in veins, nodules, and segregated on rock fragments; strongly alkaline (pH 9.0).

The A horizon is 9 to 10 inches thick. It is dark brown or brown to grayish brown or dark grayish brown when dry and very dark brown to dark brown or very dark grayish brown when moist.

The B2t horizon is 8 to 12 inches thick. It is brown, dark brown, dark grayish brown, light brown, or light yellowish brown when dry and dark brown, dark yellowish brown to brown when moist. The B2t horizon ranges from sandy clay loam to clay loam. It is usually noncalcareous or slightly calcareous, and the carbonate where present is in fine nodules and on rock fragments.

The Cca horizon is light brown or pale brown to pink or very pale brown when dry and dark brown or dark yellowish brown to light brown or light yellowish brown when moist. It ranges from sandy clay loam to loam, cobbly sandy clay loam or cobbly loam to stony sandy clay loam or stony loam. Content of rock fragments is 10 to 35 percent and is mainly cobbles or stones. In the moderately well drained soils a water table is below a depth of 40 inches, and mottles are at a depth between 20 and 40 inches.

DoB—Doyce loam, 2 to 4 percent slopes. This soil is on alluvial fans and alluvial plains. It has the profile described as representative of the series. Runoff is slow, and the hazard of erosion is moderate. This soil is well drained. Roots extend to a depth of 60 inches or more. The substratum is noncalcareous or only slightly calcareous in places.

Included with this soil in mapping are small areas of Mountainville very stony sandy loam, 2 to 8 percent slopes; Borvant very stony loam, 2 to 10 percent slopes; and Donnardo cobbly loam, 4 to 16 percent slopes.

This soil is used for irrigated small grain, alfalfa, and pasture and nonirrigated small grain or grass. Small areas are used as range. Capability units IIe-2 irrigated, IVe-UZ nonirrigated; Upland Loam range site.

DoC—Doyce loam, 4 to 8 percent slopes. This well-drained soil is on alluvial fans. Runoff is medium, and the hazard of erosion is severe. Roots extend to a depth of 60 inches or more.

Included with this soil in mapping are small areas of Mountainville very stony sandy loam, 2 to 8 percent slopes; Collard gravelly sandy loam, 4 to 8 percent slopes; and Donnardo very stony loam, 4 to 16 percent slopes.

This soil is used for irrigated small grain, alfalfa, and pasture, and nonirrigated small grain or grass. Small areas are used as range. Capability units IIIe-2 irrigated, IVe-UZ nonirrigated; Upland Loam range site.

DrB—Doyce loam, wet, 2 to 4 percent slopes. This moderately well drained soil is on the lower end of alluvial fans and alluvial plains. It has a profile similar to the one described as representative of the series,

but it is mottled at a depth between 20 and 40 inches. The seasonal water table is at a depth generally below 40 inches. Runoff is slow, and the hazard of erosion is slight. A good stand of alfalfa usually cannot be maintained more than a few years because of the water table.

Included with this soil in mapping are small areas of Beek silty clay loam; Chipman silty clay loam; and Doyce loam, 2 to 4 percent slopes.

This soil is used for irrigated alfalfa, small grain, and pasture. Capability unit IIe-2 irrigated; range site not assigned.

Dyreng Series

The Dyreng series consists of somewhat poorly drained soils that formed in alluvium derived from shale on alluvial fans and flood plains. Dyreng soils are commonly associated with Anco, Centerfield, Genola, Poganeab, and Woodrow soils. Slopes are typically smooth and are as much as 1 percent.

Elevation ranges from 5,000 to 5,200 feet. The average annual precipitation ranges from 8 to 12 inches, and the mean annual air temperature ranges from 46° to 51° F. The frost-free period is 110 to 140 days. Vegetation of the noncultivated areas is dominantly saltgrass and greasewood.

In a representative profile the surface layer is light-gray silty clay about 10 inches thick. The substratum is light brownish-gray silty clay to a depth of about 33 inches and is light-gray silty clay to a depth of 60 inches.

Dyreng soils are strongly calcareous, and reaction is moderately alkaline to strongly alkaline. Permeability is slow. The effective root zone is 60 inches or more. The seasonal water table fluctuates between depths of 30 and 60 inches or more.

Dyreng soils are used for irrigated alfalfa, small grain, corn for silage, and as pasture. Small areas are used as native range pasture and as habitat by upland game birds.

Representative profile of Dyreng silty clay, in a cultivated field 1½ miles west of Centerfield, about 1,770 feet north and 1,250 feet west of the southeast corner of sec. 25, T. 19 S., R. 1 W., Sanpete County:

Ap—0 to 10 inches, light-gray (10YR 7/2) silty clay, grayish brown (10YR 5/2) when moist; weak, coarse, sub-angular blocky structure; very hard, very firm, very sticky and very plastic; common very fine and fine roots; few very fine and medium pores; strongly calcareous; moderately alkaline (pH 8.4); abrupt, smooth boundary.

C1—10 to 20 inches, light brownish-gray (10YR 6/2) silty clay, grayish brown (10YR 5/2) when moist; weak, coarse, prismatic structure; very hard, extremely firm, very sticky and very plastic; few very fine roots; common very fine and few fine pores; strongly calcareous; strongly alkaline (pH 8.6); gradual, wavy boundary.

C2g—20 to 33 inches, light brownish-gray (10YR 5/2) silty clay, grayish brown (10YR 5/2) when moist; common, medium, distinct, dark-gray (5Y 4/1) mottles; moderate, fine, angular blocky structure; very hard, extremely firm, very sticky and very plastic; few very fine roots; few very fine pores; strongly calcareous; strongly alkaline (pH 8.8); gradual, smooth boundary.

C4g—33 to 60 inches, light-gray (10YR 7/2) silty clay, grayish brown (10YR 5/2) when moist; common, coarse, distinct, dark-gray (5Y 4/1) mottles; massive; very

hard, very firm, very sticky and very plastic; few very fine roots; few very fine pores; ½- to 1-inch red (2.5YR 5/4) layers below a depth of 43 inches; strongly calcareous; strongly alkaline (pH 8.5).

Texture between depths of 10 and 40 inches is silty clay or silty clay loam. Clay mineralogy is dominated by montmorillonite, but there are lesser amounts of other clays. Cracks ½ inch or more in width extend to a depth of 24 inches, but there are no slickensides. Salinity is slight to strong.

The A horizon is 7 to 10 inches thick. It is light gray or grayish brown to very pale brown when dry and dark grayish brown to brown or grayish brown when moist. The A horizon ranges from silty clay to silty clay loam.

The C horizon is light brownish gray, light gray, pinkish gray, or light brown to pink or very pale brown when dry. Below a depth of 43 inches there are thin red layers of soil. Below a depth of 40 inches there are stratified layers of sandy loam, loam, silty clay loam, and silty clay. Dark-gray to yellowish-brown mottles are between depths of 20 and 40 inches.

Ds—Dyreg silty clay. This soil is on alluvial fans and flood plains. Slope is 0 to 1 percent. It has the profile described as representative of the series. Runoff is slow, and the hazard of erosion is slight. The available water capacity is 8 to 12 inches.

Included with this soil in mapping are small areas of Anco silty clay loam, Shumway silty clay loam, and Dyreg silty clay, strongly saline.

Most of the acreage of this soil is used for irrigated alfalfa, small grain, corn silage, and irrigated pasture. Capability unit IIIw-2 irrigated; range site not assigned.

Dy—Dyreg silty clay, strongly saline. This soil is on alluvial fans and flood plains. It has a profile similar to the one described as representative of the series, but it is strongly saline affected above a depth of 20 inches. Slope is 0 to 1 percent. Runoff is slow, and the hazard of erosion is slight. The available water capacity is reduced by the high salt content, and water available to plants is 1 to 4 inches.

Included with this soil in mapping are small areas of Dyreg silty clay and Manassa silt loam, 1 to 5 percent slopes.

This soil is used mainly as native pasture. Capability unit VIIw-28 nonirrigated; Alkali Bottoms range site.

Ephraim Series

The Ephraim series consists of somewhat poorly drained soils that formed in alluvium derived from limestone on alluvial fans, alluvial plains, and valley bottoms. Ephraim soils are commonly associated with Anco, Dyreg, Quaker, Poganeab, and Woodrow soils. Slope is 0 to 2 percent.

Elevation ranges from 5,200 to 5,800 feet. The average annual precipitation ranges from 9 to 12 inches, and the mean annual air temperature ranges from 45° to 48° F. The frost-free period is 110 to 130 days. Vegetation is rubber rabbitbrush, saltgrass, wiregrass, and annual weeds.

In a representative profile the surface layer is light brownish-gray and light-gray silty clay loam about 13 inches thick. The substratum is very pale brown, light-gray, and light brownish-gray stratified silty clay loam and silty clay to a depth of 62 inches.

The Ephraim soils are very strongly calcareous, and

reaction is moderately alkaline to very strongly alkaline. Permeability is moderately slow. The available water capacity is about 6 inches. The high content of lime reduces the amount of available water. The seasonal water table fluctuates between depths of 30 and 60 inches or more. The root zone is 60 inches or more.

Ephraim soils are used for irrigated alfalfa, small grain, and pasture. Small areas are used as range.

Representative profile of Ephraim silty clay loam, in an abandoned field at the northwest corner of Manti-Ephraim Airport, 1,500 feet west and 1,150 feet north of the southeast corner of sec. 18, T. 17 S., R. 3 E., Sanpete County:

A11—0 to 6 inches, light brownish-gray (10YR 6/2) silty clay loam, grayish brown (10YR 5/2) when moist; weak, medium, platy structure; slightly hard, firm, slightly sticky and plastic; few medium and fine roots; few coarse, common medium and fine pores; very strongly calcareous; moderately alkaline (pH 8.2); clear, smooth boundary.

A12—6 to 13 inches, light-gray (10YR 7/2) silty clay loam, grayish brown (10YR 5/2) when moist; weak, medium, subangular blocky structure; hard, firm, sticky and plastic; few medium and fine roots; many very fine and fine pores, few medium and coarse pores; very strongly calcareous, lime in fine flakes and fine soft rounded masses; moderately alkaline (pH 8.4); clear, smooth boundary.

C1—13 to 21 inches, very pale brown (10YR 8/3) silty clay loam, pale brown (10YR 6/3) when moist; weak, medium, subangular blocky structure; hard, firm, sticky and plastic; few fine and medium roots; common very fine and few fine pores; very strongly calcareous; moderately alkaline (pH 8.4); clear, smooth boundary.

C2—21 to 30 inches, light-gray (10YR 7/2) silty clay loam, grayish brown (10YR 5/2) when moist; few fine, distinct, yellowish-brown (10YR 5/4) mottles; weak, medium, subangular blocky structure; very hard, firm, sticky and plastic; many very fine, many fine, few medium, and few coarse pores; few worm casts and krotovinas; very strongly calcareous, lime in fine flakes and veins; strongly alkaline (pH 8.7); abrupt, smooth boundary.

A13b—30 to 37 inches, light brownish-gray (10YR 6/2) finely stratified silty clay loam and light silty clay, grayish brown (2.5Y 5/2) when moist; few, fine, distinct, dark-gray (2.5Y 4/1) mottles; weak, medium, prismatic structure; hard, very firm, sticky and plastic; few fine roots; many very fine and fine pores; very strongly calcareous; strongly alkaline (pH 8.5); abrupt, smooth boundary.

C3—37 to 41 inches, light brownish-gray (2.5Y 6/2) silty clay loam, dark grayish-brown (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) when moist; few, fine, distinct, yellowish-brown (10YR 5/4) mottles; massive; hard, firm, sticky and plastic; few very fine roots; many very fine and fine pores; very strongly calcareous; moderately alkaline (pH 8.4); abrupt, smooth boundary.

A14b—41 to 51 inches, light brownish-gray (2.5Y 6/2) silty clay, grayish brown (2.5Y 5/2) when moist; moderate, medium, prismatic structure; very hard, very firm, sticky and very plastic; few very fine roots; many very fine and fine pores; very strongly calcareous; strongly alkaline (pH 8.6); abrupt, smooth boundary.

C4—51 to 62 inches, light-gray (10YR 7/2) silty clay loam, pale brown (10YR 6/3) when moist; massive; very hard, firm, sticky and plastic; many very fine pores; very strongly calcareous, lime in fine veins; strongly alkaline (pH 8.6).

Depth to mottling is between 20 and 40 inches. If the soil does not have mottles, it is gray or light gray when dry. Between depths of 10 and 40 inches the soil ranges from silty clay to silty clay loam or clay loam but is typically silty clay loam.

The A horizon is 9 to 18 inches thick. It is light brownish gray or pale brown to light gray or very pale brown when dry and grayish brown, dark grayish brown, or brown when moist.

The C horizon is light grayish brown, gray, or grayish brown to light gray, white, or very pale brown when dry and dark grayish brown, pale brown, grayish brown, dark gray or gray, or light brownish gray when moist. Below a depth of 40 inches the soil ranges from loamy sand to silty clay but is typically silty clay or silty clay loam.

Ep—Ephraim silty clay loam. This soil is on alluvial fans and valley bottoms (fig. 6). Slope is 0 to 2 percent. Runoff is slow, and the hazard of erosion is slight.

Included with this soil in mapping are small areas of Shumway silty clay loam; Shumway silty clay loam, drained; and Anco silty clay loam.

This soil is used for irrigated alfalfa, small grain, and pasture. Small areas are used as range. Capability units IIIw-2 irrigated, VIw-2 nonirrigated; Semi-wet Meadows range site.



Figure 6.—Ephraim silty clay loam. The darker layers between depths of 2½ and 4½ feet are the surface layers of old buried soils.

Fluvaquents

FN—Fluvaquents are recent alluvial deposits on stream flood plains. The alluvium is stratified and ranges from loamy sand to clay, but it is dominantly sandy loam, silt loam, loam, or clay loam. Texture varies widely within very short distances. Pondered water is common in swales and low areas, such as oxbow loops and meander bars. Depth to the water table typically ranges to about 20 inches, but late in dry summers the water table may be at a depth of 30 to 40 inches. Typically there is a layer of organically rich soil on the surface. Vegetation is wiregrass, tules, and cattails.

These soils are used for pasture, and in places they are cut for native grass hay. They are also used as a nesting area by waterfowl and upland game birds. Capability unit Vw-2 nonirrigated; Wet Meadows range site.

Flygare Series

The Flygare series consists of well-drained soils that formed in colluvium derived from sandstone and limestone on mountainsides. Flygare soils are commonly associated with Adel, Bradshaw, Cheadle, and Daybell soils. Slope is 50 to 80 percent.

Elevation ranges from 8,000 to 9,000 feet. The average annual precipitation ranges from 20 to 30 inches, and the mean annual air temperature ranges from 38° to 40° F. The frost-free period is 75 to 90 days. Vegetation is alpine fir and Engelmann spruce.

In a representative profile the surface layer is very dark brown and dark-brown gravelly silt loam about 24 inches thick. The subsoil is yellowish-brown very gravelly light clay loam about 12 inches thick. The substratum to a depth of 60 inches is dark-brown very cobbly very fine sandy loam.

Reaction is medium acid to neutral. Permeability is moderate. The available water capacity is 3 to 5 inches. The water-supplying capacity is 10 to 14 inches annually. The effective root zone is 60 inches or more.

Flygare soils are used for woodland of alpine fir and Engelmann spruce. They are mapped only with Daybell soils.

Representative profile of Flygare gravelly silt loam, 50 to 80 percent slopes, in a wooded area of Daybell-Flygare association, very steep, about 500 feet west of the radar reflector towers on the summit of Loafer Mountain, about 1,980 feet north and 330 feet east of the southwest corner of sec. 27, T. 9 S., R. 3 E., Utah County:

- A11—0 to 3 inches, very dark brown (10YR 3/2) gravelly silt loam, very dark brown (10YR 2/2) when moist; weak, fine, granular structure; soft, very friable, non-sticky and nonplastic; few fine roots; few fine pores; 25 percent angular gravel; slightly acid (pH 6.2); clear, smooth boundary.
- A12—3 to 15 inches, dark-brown (10YR 4/3) crushed, brown (10YR 5/3) on faces of peds, gravelly silt loam, very dark grayish brown (10YR 3/2) when moist; some clay stripping; weak, fine, subangular blocky structure; slightly hard, friable, slightly sticky and plastic; few coarse, medium, and fine roots; 25 percent angular gravel; slightly acid (pH 6.3); clear, wavy boundary.

A13—15 to 24 inches, dark-brown (10YR 4/3) crushed, brown (10YR 5/3) on faces of peds, gravelly silt loam, very dark grayish brown (10YR 3/2) when moist; some clay stripping; moderate, fine, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few medium and fine roots; common very fine pores; 40 percent angular gravel; slightly acid (pH 6.2); clear, wavy boundary.

B2t—24 to 36 inches, yellowish-brown (10YR 5/4) very gravelly light clay loam, dark yellowish brown (10YR 3/4) when moist; moderate, medium, subangular blocky structure; hard, firm, sticky and plastic; few fine and medium roots; few very fine pores; common, moderately thick clay films on rock fragments; 50 percent angular gravel, 5 percent cobbles; slightly acid (pH 6.2); gradual, wavy boundary.

C1—36 to 60 inches, dark-brown (10YR 4/3) very cobbly very fine sandy loam, very dark brown (10YR 2/2) when moist; massive; slightly hard, friable, slightly sticky and plastic; 80 percent angular cobbles and gravel, some segregated lime on bottom of some rock fragments; neutral (pH 6.8).

The A horizon is 24 to 30 inches thick. It is dark brown or very dark grayish brown to brown when dry and very dark brown to dark brown or very dark grayish brown when moist. It ranges from silt loam or gravelly silt loam to very fine sandy loam or gravelly very fine sandy loam. Content of gravel is 10 to 45 percent.

The B2t horizon is 10 to 16 inches thick. It is yellowish brown, brown, light brown, pale brown, or light yellowish brown when dry and dark yellowish brown, very dark grayish brown, brown, or dark brown when moist. The B2t horizon ranges from gravelly or very gravelly sandy clay loam or cobbly or very cobbly sandy clay loam to gravelly or very gravelly clay loam or cobbly or very cobbly clay loam. Rock fragments, mainly gravel, make up 40 to 70 percent of the horizon.

The C horizon is dark brown or dark grayish brown to pale brown or light yellowish brown when moist. It ranges from very gravelly or very cobbly very fine sandy loam to very gravelly or very cobbly fine sandy loam. Content of angular cobbles or gravel is 50 to 80 percent.

This soil does not have the A2 horizon that is characteristic of the Flygare series, but this does not alter its usefulness or behavior.

Fontreen Series

The Fontreen series consists of somewhat excessively drained soils that formed in alluvium and colluvium derived from limestone, sandstone, chert, and shale on mountainsides and alluvial fans. Fontreen soils are commonly associated with Atepic, Borvant, Lodar, and Wales soils. Slope is 4 to 70 percent.

Elevation ranges from 6,000 to 7,000 feet. The average annual precipitation ranges from 11 to 14 inches, and the mean annual air temperature ranges from 43° to 45° F. The frost-free period is 90 to 100 days. Vegetation is dominantly juniper, pinon, shrubs, and perennial grasses.

In a representative profile the surface layer is dark grayish brown very cobbly and very gravelly loam about 15 inches thick. The substratum to a depth of 60 inches or more is pale-brown, very pale brown, pinkish-gray, and pink very gravelly loam.

Fontreen soils are very strongly calcareous, and reaction is mildly alkaline to very strongly alkaline. Permeability is moderately rapid. The available water capacity is 4 to 6 inches. The water-supplying capacity is 5 to 8 inches annually. The effective root zone is about 60 inches or more, but roots are somewhat restricted by gravel or cobbles below a depth of 36 inches.

Fontreen soils are used as spring and fall range by sheep and cattle and as winter range by deer. Some areas of these soils are wooded. They are also a source of road fill.

Representative profile of Fontreen very cobbly loam, 40 to 70 percent slopes, eroded, in a range area about 3 miles east of Sterling in Funk's Canyon, about 1,600 feet west and 2,800 feet south of the northeast corner of sec. 2, T. 19 S., R. 2 E., Sanpete County:

A11—0 to 4 inches, dark grayish-brown (10YR 4/2) very cobbly loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft, friable, slightly sticky and plastic; many very fine and fine roots; 55 percent cobbles and stones mainly as a surface mantle; strongly calcareous; moderately alkaline (pH 7.9); clear, smooth boundary.

A12—4 to 7 inches, dark grayish-brown (10YR 4/2) gravelly loam, very dark grayish brown (10YR 3/2) when moist; weak, thick, platy structure parting to weak, fine, granular; slightly hard, friable, slightly sticky and plastic; many very fine and fine roots; few fine pores; 45 percent gravel; strongly calcareous, soft powdery lime on the bottom of pebbles; moderately alkaline (pH 7.5); gradual, wavy boundary.

A13—7 to 15 inches, dark grayish-brown (10YR 4/2) very gravelly loam, dark brown (10YR 3/3) when moist; weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky and plastic; many very fine and common fine roots; few fine pores; 60 percent rock fragments, mainly gravel; strongly calcareous, lime segregated on bottom of rock fragments; moderately alkaline (pH 7.9); clear, smooth boundary.

C1ca—15 to 21 inches, pale-brown (10YR 6/3) very gravelly loam, brown (10YR 5/3) when moist; massive; slightly hard, friable, sticky and plastic; common very fine roots; few very fine pores; 60 percent rock fragments, mainly gravel; very strongly calcareous, lime segregated on rock fragments and in soft flakes and veins; moderately alkaline (pH 8.1); gradual, wavy boundary.

C2ca—21 to 29 inches, very pale brown (10YR 7/3) very gravelly loam, pale brown (10YR 6/3) when moist; massive; hard, friable, slightly sticky and plastic; few very fine and fine roots; few fine pores; 60 percent rock fragments, mainly gravel; very strongly calcareous, lime segregated on rock fragments, in flakes, veins, and rounded masses; moderately alkaline (pH 8.4); clear, wavy boundary.

C3ca—29 to 44 inches, pinkish-gray (7.5YR 7/2) very gravelly loam, pinkish gray (7.5YR 6/2) when moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; few fine pores; 65 percent rock fragments, mainly gravel; very strongly calcareous, lime segregated on rock fragments; strongly alkaline (pH 8.6); gradual, smooth boundary.

C4ca—44 to 58 inches, pink (7.5YR 7/3) very gravelly loam, light brown (7.5YR 6/3) when moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine and fine roots; few very fine pores; 70 percent rock fragments, mainly gravel; very strongly calcareous, lime segregated on the rock fragments and some nodules; strongly alkaline (pH 8.5); gradual, wavy boundary.

C5—58 to 66 inches, pink (7.5YR 7/3) very gravelly light loam, light brown (7.5YR 6/3) when moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common fine and very fine roots; 85 percent rock fragments, mainly gravel; very strongly calcareous; strongly alkaline (pH 8.6).

Texture between depths of 10 and 40 inches is typically very gravelly or very cobbly loam but ranges from gravelly, very gravelly, cobbly, or very cobbly sandy loam to gravelly, very gravelly, cobbly, or very cobbly clay loam. Content of gravel and cobbles ranges from 35 to 70 percent.

The A horizon is 8 to 19 inches thick. It is dark grayish brown or brown to grayish brown when dry and very dark grayish brown to dark brown or very dark brown when moist. It is cobbly loam, very cobbly loam, gravelly loam,

or very gravelly loam. Content of gravel and cobbles is 20 to 60 percent.

The Cca horizon is pale brown, light brown to pink, pinkish gray, or very pale brown when dry and dark brown, dark grayish brown, or brown to light brown, pinkish gray, or pale brown when moist. The Cca horizon is 24 to 52 inches thick. It ranges from very gravelly or very cobbly loam to very gravelly or very cobbly sandy loam below a depth of 40 inches.

FOD—Fontreen cobbly loam, 4 to 20 percent slopes.

This soil is on alluvial fans. It has a profile similar to the one described as representative of the series, but the surface layer contains 20 to 50 percent gravel and cobbles. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Clegg loam, 3 to 18 percent slopes; Fontreen very cobbly loam, 20 to 40 percent slopes, eroded; and Borvant cobbly loam, 8 to 25 percent slopes, eroded. An area of 200 acres on the west side of North Hollow near Mayfield is extensively cut by ravines and includes areas of nearly barren shale outcrops. The areas between the ravines are 150 to 500 feet wide.

This soil is used as spring and fall range by sheep and cattle and as winter range for deer. Chaining off juniper and pinon and seeding to grass has been successful on this soil. The soil is also used for woodland. The juniper is harvested for cedar posts, and both the juniper and pinon are used for firewood. This soil is a good source of road fill. Capability unit VIs-U nonirrigated; Upland Stony Loam (Juniper-Pinon) range site.

FRE2—Fontreen very cobbly loam, 20 to 40 percent slopes, eroded. This soil is on foothills. It has a profile similar to the one described as representative of the series, but 2 to 10 percent of the surface is covered by stones in places. Runoff is medium, and the hazard of erosion is moderate. Sheet erosion is active, and there are usually rills and deep gullies in places.

Included with this soil in mapping are small areas of Lizzant very cobbly loam, 20 to 40 percent slopes; Lodar very channery loam, 8 to 40 percent slopes; Atepic shaly clay loam, 10 to 30 percent slopes, eroded; and Rock outcrop.

This soil is used as spring and fall range by sheep and cattle and as winter range by deer. Chaining to remove juniper and pinon and seeding to grass has been successful in places. This soil is also used for woodland. The juniper is harvested for cedar posts, and both the juniper and pinon are used for firewood. This soil is only a fair source of road fill because of the steep slopes. Capability unit VIIs-U nonirrigated; Upland Stony Loam (Juniper-Pinon) range site.

FRG2—Fontreen very cobbly loam, 40 to 70 percent slopes, eroded. This soil is on mountainsides. It has the profile described as representative of the series (fig. 7). Runoff is medium, and the hazard of erosion is severe. Sheet and rill erosion are active, and there are deep gullies in places. On some ridges the surface layer has been removed and the whitish, limy underlying layer has been exposed.

Included with this soil in mapping are small areas of Lizzant very stony loam, 40 to 70 percent slopes; Rock outcrop; and places where 2 to 10 percent of the surface is covered by stones.



Figure 7.—Fontreen very cobbly loam, 40 to 70 percent slopes, eroded. This soil is more than 40 percent lime between depths of 10 and 40 inches.

This soil is used as spring and fall range by sheep and cattle and as winter range by deer. Capability unit VIIs-U nonirrigated; Upland Stony Loam (Juniper-Pinon) range site.

FSD2—Fontreen-Borvant complex, 4 to 25 percent slopes, eroded. This mapping unit is on alluvial fans and sides of foothills. It is about 45 percent Fontreen cobbly loam, 4 to 20 percent slopes, in swales, depressions, and more nearly level areas; about 40 percent Borvant cobbly loam, 8 to 25 percent slopes, eroded, on ridges and broad side slopes; about 15 percent Lodar very channery loam, 8 to 40 percent slopes, on ridges;

small areas of Wales loam, 2 to 8 percent slopes; Clegg loam, 3 to 10 percent slopes; and areas that have more than 50 percent cobbles on the surface.

The Fontreen cobbly loam, 4 to 20 percent slopes, has a profile similar to the one described as representative of the Fontreen series, but the surface layer contains less than 50 percent cobbles and gravel. Runoff is medium, and the hazard of erosion is moderate.

This mapping unit is used as spring and fall range by sheep and cattle and as winter range by deer. Chaining to remove the juniper and pinon and seeding to grass has been successful in some areas. These soils are also used for woodland. The juniper is harvested for cedar posts, and both juniper and pinon are used for firewood. These soils are a fair source of road fill. Capability unit VI-S-U nonirrigated; Fontreen soil in Upland Stony Loam (Juniper-Pinon) range site; Borvant soil in Upland Shallow Hardpan (Juniper-Pinon) range site.

Freedom Series

The Freedom series consists of well-drained soils that formed in alluvium derived from shale, sandstone, and limestone on alluvial fans and alluvial plains. Freedom soils are commonly associated with Amtoft, Denmark, Moroni, and Woodrow soils. Slope is 2 to 10 percent.

Elevation ranges from 5,000 to 6,000 feet. The average annual precipitation ranges from 10 to 12 inches, and the mean annual air temperature ranges from 45° to 49° F. The frost-free period is 100 to 120 days. Vegetation is big sagebrush, Indian ricegrass, squirreltail, and greasewood.

In a representative profile the surface layer is pale-brown silt loam about 8 inches thick. The substratum is pale-yellow silty clay loam to a depth of 30 inches and light yellowish-brown silty clay loam to a depth of 60 inches.

Freedom soils are moderately calcareous to strongly calcareous, and reaction is moderately alkaline to very strongly alkaline. Permeability is moderately slow. The available water capacity is 8 to 12 inches. The water-supplying capacity of nonirrigated soils is 6 to 8 inches annually. The effective root zone is 60 inches or more.

Freedom soils are used for nonirrigated grass pasture and as range.

Representative profile of Freedom silt loam, 2 to 10 percent slopes, in an area of Freedom-Amtoft complex, 2 to 30 percent slopes, in a nonirrigated grass pasture 1½ miles east of the Moroni feed mill; about 1,650 feet north and 660 feet west of the southeast corner of sec. 14, T. 15 S., R. 3 E., Sanpete County:

A11—0 to 3 inches, pale-brown (10YR 6/3) silt loam, dark brown (10YR 4/3) when moist; weak, thin, platy structure; slightly hard, friable, slightly sticky and plastic; few fine and very fine roots; few fine and very fine pores; moderately calcareous; moderately alkaline (pH 8.4); abrupt, smooth boundary.

A12—3 to 8 inches, pale-brown (10YR 6/3) silt loam, dark brown (10YR 4/3) when moist; weak, coarse, subangular blocky structure; slightly hard, friable, slightly sticky and plastic; few fine and very fine roots; common very fine and few fine pores; moderately calcareous; moderately alkaline (pH 8.3); clear, smooth boundary.

C1ca—8 to 18 inches, pale-yellow (2.5Y 7/3) silty clay loam, light olive brown (2.5Y 5/3) when moist; weak, fine, prismatic structure that parts to weak, medium, subangular blocky; hard, firm, sticky and plastic; few very fine roots; common very fine and few fine pores; strongly calcareous, lime in fine veins and fine soft rounded masses; strongly alkaline (pH 8.8); gradual, smooth boundary.

C2ca—18 to 30 inches, pale-yellow (2.5Y 7/3) light silty clay loam, light olive brown (2.5Y 5/3) when moist; weak, coarse, prismatic structure; hard, firm, sticky and plastic; few very fine roots; common fine and very fine pores; strongly calcareous, lime in fine veins and fine soft rounded masses; strongly alkaline (pH 9.0); clear, smooth boundary.

C3—30 to 40 inches, light yellowish-brown (2.5Y 6/3) light silty clay loam, light olive brown (2.5Y 5/3) when moist; massive; hard, firm, sticky and plastic; few very fine roots; common very fine and few fine pores; few pockets of gravel; strongly calcareous, lime in fine veins; very strongly alkaline (pH 9.2); gradual, smooth boundary.

C4—40 to 60 inches, light yellowish-brown (2.5Y 6/3) light silty clay loam, light olive brown (2.5Y 5/3) when moist; massive; slightly hard, firm, sticky and plastic; few very fine roots; common fine and very fine pores; strongly calcareous, lime in fine veins; very strongly alkaline (pH 9.4).

Texture between depths of 10 and 40 inches is typically silty clay loam but ranges from silt loam to silty clay loam.

The A horizon is 7 to 13 inches thick. It is pale brown or light brownish gray to light gray, pale yellow, or very pale brown when dry and dark brown, dark grayish brown, or brown to grayish brown or light olive brown when moist.

The Cca horizon is 6 to 50 inches thick. It is pale yellow, light brownish gray, or light yellowish brown to very pale brown when dry and light olive brown, dark grayish brown, brown, or light brownish gray to pale brown when moist. Below a depth of 40 inches the C horizon ranges from silty clay loam to gravelly sandy loam.

FTD—Freedom-Amtoft complex, 2 to 30 percent slopes. This mapping unit is on alluvial fans and foothills. It is about 65 percent Freedom silt loam, 2 to 10 percent slopes, in gently sloping areas and on the lower fans; 25 percent Amtoft flaggy loam, 8 to 30 percent slopes, on ridges and knolls; small areas of Moroni silty clay, 2 to 8 percent slopes; a soil that is 30 to 40 inches deep over shale; and a soil similar to Billings silty clay loam.

In places limestone flagstones that have rolled or slid down from the higher lying limestone capped ridges are on the surface. Runoff is medium in this mapping unit, and the hazard of erosion is moderate.

The Freedom soil is used for nonirrigated grass pasture and as range. The Amtoft soil is used only as range. Capability unit VIe-S nonirrigated; Freedom soil in Semi-desert Loam range site, Amtoft soil in Semi-desert Shallow Loam range site.

Gappmayer Series

The Gappmayer series consists of well-drained soils that formed in colluvium and alluvium derived from mixed sedimentary rock, mainly sandstone, in swales, small canyons, and on northern exposures. Gappmayer soils are commonly associated with Bezzant, Bradshaw, and Daybell soils. Slope is 60 to 80 percent.

Elevation ranges from 5,500 to 7,200 feet. The average annual precipitation ranges from 18 to 25 inches, and the mean annual air temperature ranges from 43° to 45° F. The frost-free period is 80 to 90

days. Vegetation is oakbrush, snowberry, mountain sedge, and chokecherry.

In a representative profile the surface layer is dark grayish-brown and brown cobbly loam about 12 inches thick. The subsurface layer is brown very cobbly loam about 14 inches thick. The subsoil is brown very cobbly sandy clay loam about 28 inches thick. The substratum is light-gray very gravelly very fine sandy loam to a depth of 72 inches.

Reaction is medium acid to neutral to a depth of about 50 inches; below this depth reaction is neutral to moderately alkaline. Permeability is rapid. The available water capacity is $3\frac{1}{2}$ to 6 inches. The water-supplying capacity is about 8 to 12 inches annually. The effective root zone is 60 inches or more.

Gappmayer soils are used as range by deer and elk and as catchment areas for watersheds. They are mapped only with Bezzant soils and Rock land.

Representative profile of Gappmayer cobbly loam, 60 to 80 percent slopes, in a range area of Bezzant-Gappmayer-Rock land association, very steep, on the Dream Mine Road about $\frac{1}{8}$ mile below the saddle at the top of the first switchback on the east side of the road, about 990 feet north and 3,630 feet east of the southwest corner of sec. 8, T. 9 S., R. 3 E., Utah County:

A11—0 to 4 inches, dark grayish-brown (10YR 4/2) cobbly loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, granular structure; slightly hard, friable, slightly sticky and slightly plastic; common fine and very fine and few medium roots; 30 percent cobbles and gravel; neutral (pH 7.3); clear, smooth boundary.

A12—4 to 12 inches, brown (10YR 5/3) cobbly loam, dark brown (10YR 3/3) when moist; moderate, medium, granular structure; slightly hard, friable, slightly sticky and slightly plastic; common fine and very fine roots; few interstitial pores; 45 percent cobbles and gravel; neutral (pH 7.3); clear, wavy boundary.

A21—12 to 20 inches, brown (7.5YR 5/2) very cobbly loam, dark brown (7.5YR 4/2) when moist; weak, medium, subangular blocky structure; hard, friable, sticky and plastic; common very fine roots; 50 percent cobbles and gravel; neutral (pH 7.3); gradual, smooth boundary.

A22—20 to 26 inches, brown (7.5YR 5/3) very cobbly loam, dark brown (7.5YR 4/3) when moist; moderate, medium, subangular blocky structure; hard, friable, slightly sticky and plastic; common very fine roots; 55 percent angular cobbles and gravel; neutral (pH 7.3); gradual, wavy boundary.

B21t—26 to 36 inches, brown (7.5YR 5/4) very cobbly sandy clay loam, dark brown (7.5YR 4/4) when moist; moderate, medium, subangular blocky structure; hard, friable, sticky and plastic; few fine interstitial pores; common thin clay films; 65 percent rock fragments, mainly cobbles and gravel; neutral (pH 7.2); gradual, wavy boundary.

B22t—36 to 54 inches, brown (7.5YR 5/4) very cobbly sandy clay loam, dark brown (7.5YR 4/4) when moist; weak, fine, subangular blocky structure; hard, friable, sticky and plastic; few very fine roots; few fine interstitial pores; common moderately thick clay films; 65 percent rock fragments, mainly angular cobbles and gravel; neutral (pH 7.2); clear, wavy boundary.

Cca—54 to 72 inches, light-gray (2.5Y 7/2) very gravelly very fine sandy loam, grayish brown (2.5Y 5/2) when moist; massive; very hard, friable, slightly sticky and slightly plastic; 80 percent cobbles and gravel; strongly calcareous, lime in veins; moderately alkaline (pH 8.2).

The A1 horizon is 7 to 16 inches thick. It is very dark grayish brown or dark grayish brown to brown or grayish brown when dry and very dark grayish brown, black, or very dark brown to dark brown or dark grayish brown when moist. The A2 horizon is 6 to 20 inches thick. It is brown or grayish brown to pink or very pale brown when dry and

dark brown or dark grayish brown to light brown or pale brown when moist. The A2 horizon ranges from very cobbly loam to very cobbly light loam and is 40 to 60 percent cobbles.

The B2t horizon is brown or grayish brown to light brown or pale brown when dry and dark brown or dark grayish brown to brown when moist. The B2t horizon is very cobbly loam to very cobbly sandy clay loam 14 to 30 inches thick. Content of rock fragments, mainly cobbles, is 50 to 80 percent.

The Cca horizon is at depths below 50 inches in places.

Genola Series

The Genola series consists of well-drained soils that formed in alluvium derived from sandstone, shale, and limestone on alluvial fans and alluvial plains. Genola soils are most commonly associated with Anco, Centerfield, Dyreng, Linoyer, and Woodrow soils. Slope ranges from 0 to 10 percent.

Elevation ranges from 5,100 to 6,000 feet. The average annual precipitation ranges from 8 to 12 inches, and the mean annual air temperature ranges from 45° to 49° F. The frost-free period ranges from 115 to 130 days. Vegetation in the noncultivated areas is dominantly big sagebrush, shadscale, bud sagebrush, and Indian ricegrass.

In a representative profile the surface layer is pale-brown loam about 13 inches thick. The substratum to a depth of 60 inches is pale-brown, very pale brown, and pink stratified loam, silt loam, silty clay loam, very fine sandy loam, fine sandy loam, and loamy fine sand.

The Genola soils are strongly calcareous, and reaction is moderately alkaline to very strongly alkaline. The soils are strongly saline-alkali above a depth of 20 inches in places. Permeability is moderate. The effective root zone is 60 inches or more.

Genola soils are used mainly for irrigated alfalfa, small grain, corn silage, sugar beets, and improved pasture. They are also used as range and as habitat for upland game birds.

Representative profile of Genola loam, 0 to 2 percent slopes, in a cultivated field, $1\frac{1}{4}$ miles west and 1 mile south of Gunnison, about 1,650 feet west and 825 feet north of the southeast corner of sec. 19, T. 19 S., R. 1 E., Sanpete County:

Ap1—0 to 7 inches, pale-brown (10YR 6/3) loam, brown (10YR 5/3) when moist; weak, thick, platy structure that parts to moderate, fine, subangular blocky; slightly hard, firm, sticky and plastic; few fine roots; few fine and medium pores; common worm casts; strongly calcareous; moderately alkaline (pH 8.3); clear, wavy boundary.

Ap2—7 to 13 inches, pale-brown (10YR 6/3) loam, dark brown (10YR 4/3) when moist; weak, medium, subangular blocky structure; slightly hard, firm, slightly sticky and plastic; few very fine and fine roots; few fine and medium pores; strongly calcareous; strongly alkaline (pH 8.6); abrupt, smooth boundary.

C1—13 to 19 inches, pale-brown (10YR 6/3) loam, dark yellowish brown (10YR 4/4) when moist; weak, coarse, subangular blocky structure; hard, friable, slightly sticky and plastic; few very fine and fine roots; common very fine and fine and few medium pores; common worm casts; strongly calcareous; strongly alkaline (pH 8.5); abrupt, smooth boundary.

C2—19 to 23 inches, pink (7.5YR 7/3) silt loam, brown (7.5YR 5/3) when moist; weak, fine and medium, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; common very fine, fine, medium, and few coarse pores; few

worm casts; strongly calcareous; strongly alkaline (pH 8.4); abrupt, smooth boundary.

Ab—23 to 31 inches, very pale brown (10YR 7/3) silty clay loam, yellowish brown (10YR 5/4) when moist; massive; hard, firm, sticky and plastic; few very fine and fine roots; common very fine, fine, and few medium pores; strongly calcareous; strongly alkaline (pH 8.8); abrupt, smooth boundary.

C3—31 to 34 inches, pale-brown (10YR 6/3) silt loam, yellowish brown (10YR 5/4) when moist; massive; hard, firm, sticky and plastic; few very fine roots; common fine and very fine pores; strongly calcareous; strongly alkaline (pH 8.7); abrupt, smooth boundary.

C4—34 to 42 inches, pale-brown (10YR 6/3) stratified loam to very fine sandy loam, yellowish brown (10YR 5/4) when moist; massive; slightly hard, firm, sticky and plastic; few fine roots; common fine and very fine pores; strongly calcareous; strongly alkaline (pH 8.6); abrupt, smooth boundary.

C5—42 to 45 inches, pale-brown (10YR 6/3) fine sandy loam, yellowish brown (10YR 5/4) when moist; slightly hard, very friable, slightly sticky and slightly plastic; strongly calcareous; strongly alkaline (pH 8.5); abrupt, smooth boundary.

C6—45 to 47 inches, very pale brown (10YR 7/3) silty clay loam, yellowish brown (10YR 5/4) when moist; massive; very hard, firm, sticky and plastic; common fine and very fine pores; strongly calcareous; strongly alkaline (pH 8.8); abrupt, smooth boundary.

C7—47 to 51 inches, pink (7.5YR 7/3) loamy fine sand, light brown (7.5YR 6/3) when moist; stratified by thin lenses of red silt loam; massive; soft, very friable, non-sticky and nonplastic; strongly calcareous; strongly alkaline (pH 8.5); abrupt, smooth boundary.

C8—51 to 61 inches, very pale brown (10YR 7/3) finely stratified silty clay loam to very fine sandy loam, yellowish brown (10YR 5/4) when moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine pores; strongly calcareous; strongly alkaline (pH 8.8); clear, smooth boundary.

Texture between depths of 10 and 40 inches is stratified silty clay loam, very fine sandy loam, loam, and silt loam that averages loam. Salinity ranges from none or slightly saline to strongly saline affected above a depth of 20 inches.

The A horizon is 6 to 13 inches thick. It is pale brown or brown to light brown when dry and dark brown or brown to grayish brown when moist. The A horizon ranges from loam to silt loam.

The C horizon is light brown or pale brown to pink or very pale brown when dry and is brown to light brown, yellowish brown, or very pale brown when moist. Below a depth of 40 inches it is stratified loamy sand to clay.

GeB—Genola loam, 0 to 2 percent slopes. This soil is on alluvial fans and alluvial plains. It has the profile described as representative of the series. Runoff is slow, and the hazard of erosion is slight. The available water capacity is 8 to 11 inches. The water-supplying capacity of nonirrigated soils is 6 to 8 inches annually.

Included with this soil in mapping are small areas of Woodrow silty clay loam, 0 to 2 percent slopes, and Linoyer very fine sandy loam, 1 to 2 percent slopes.

Most of the acreage of this soil is used for irrigated alfalfa, small grain, corn silage, sugar beets, and pasture. Some small areas are used as range. This soil is also used as habitat by upland game birds and small game. Capability units IIe-2 irrigated, VIIe-S nonirrigated; Semi-desert Loam range site.

GeC2—Genola loam, 2 to 5 percent slopes, eroded. This soil is on alluvial fans and alluvial plains. It has a profile similar to the one described as representative of the series, but it is moderately eroded and gravel and cobbles are below a depth of 40 inches in places. Runoff is medium, and the hazard of erosion is

moderate. There is moderate sheet and rill erosion, and there are a few gullies. The available water capacity is 8 to 11 inches. The water-supplying capacity of nonirrigated soils is 6 to 8 inches annually.

Included with this soil in mapping are small areas of Linoyer very fine sandy loam, 2 to 5 percent slopes, eroded; Genola loam, 5 to 10 percent slopes, eroded; Genola loam, 0 to 2 percent slopes; and Woodrow silty clay loam, 2 to 5 percent slopes, eroded.

This soil is used for irrigated alfalfa, small grain, and pasture. It is also used as range and as habitat for upland game birds. Capability units IIIe-2 irrigated, VIIe-S nonirrigated; Semi-desert Loam range site.

GeD2—Genola loam, 5 to 10 percent slopes, eroded. This soil is on alluvial fans. It has a profile similar to the one described as representative of the series, but it is moderately eroded. Runoff is rapid, and the hazard of erosion is severe. Sheet and rill erosion are moderate, and there are a few gullies. The available water capacity is 8 to 11 inches. The water-supplying capacity of nonirrigated soils is 6 to 8 inches annually.

Included with this soil in mapping are areas of Genola loam, 2 to 5 percent slopes, eroded, and Linoyer very fine sandy loam, 2 to 5 percent slopes, eroded.

This soil is used mainly as range, but in a few areas it is used for irrigated alfalfa and pasture. Capability units IVe-2 irrigated, VIIe-S nonirrigated; Semi-desert Loam range site.

GkB—Genola loam, alkali, 0 to 2 percent slopes. This soil is on alluvial fans and alluvial plains. It has a profile similar to the one described as representative of the series, but it is strongly saline and very strongly alkaline above a depth of 20 inches. Runoff is slow, and the hazard of erosion is moderate. The available water capacity is reduced to 1½ to 2½ inches because of the salt content. The water-supplying capacity is less than 4 inches annually. Vegetation is mainly greasewood.

Included with this soil in mapping are areas of Manassa silt loam, 1 to 5 percent slopes, and Genola loam, 0 to 2 percent slopes.

This soil is used as range. Capability unit VIIs-S8 nonirrigated; Semi-desert Alkali Flats range site.

Gothic Series

The Gothic series consists of well-drained soils that formed in colluvium derived from mixed sedimentary rock, mainly sandstone, on mountainsides. Gothic soils are commonly associated with Mortenson and Skylick soils. Slope is 20 to 40 percent.

Elevation ranges from 8,000 to 9,300 feet. The average annual precipitation ranges from 20 to 30 inches, and the mean annual air temperature ranges from 41° to 43° F. The frost-free period is 80 to 90 days. Vegetation is fringed sagewort, sneezeweed, perennial grasses, and a few conifers and aspens.

In a representative profile the surface layer is brown stony loam and light clay loam about 12 inches thick. The subsoil is light yellowish-brown clay, stony clay, and cobbly silty clay about 27 inches thick. The substratum is light yellowish-brown stony silty clay and stony sandy clay loam to a depth of 60 inches.

Permeability is slow. The available water capacity is 7 to 10 inches. The water-supplying capacity is 14 to 20 inches annually. The effective root zone is 60 inches or more.

Gothic soils are used as summer range by sheep, cattle, deer, and elk. They are also used as water catchment areas for watersheds and for esthetic purposes.

Representative profile of Gothic stony loam, 25 to 40 percent slopes, eroded, in a range area at the head of the South Fork of Coal Fork Canyon near the forest boundary fence, 1,400 feet south and 40 feet west of the northeast corner of sec. 27, T. 15 S., R. 5 E., Sanpete County:

A11—0 to 4 inches, brown (10YR 5/3) stony loam, dark brown (10YR 3/3) when moist; moderate, fine, granular structure; slightly hard, friable, nonsticky and plastic; common very fine roots; common very fine pores; neutral (pH 6.6); clear, smooth boundary.

A12—4 to 12 inches, brown (10YR 5/3) light clay loam, dark brown (10YR 3/3) when moist; weak, medium, subangular blocky structure parting to moderate, fine, granular; hard, firm, sticky and plastic; common fine and very fine roots; few fine and very fine pores; slightly acid (pH 6.4); abrupt, smooth boundary.

B21t—12 to 20 inches, light yellowish brown (2.5Y 6/4) crushed and olive brown (2.5Y 4/4) on faces of peds, clay, light olive brown (2.5Y 5/4) when moist; moderate, fine, prismatic structure parting to strong, medium, angular blocky; extremely hard, very firm, sticky and plastic; few very fine roots; common very fine discontinuous pores; common thin clay films; 15 percent cobbles and stones; clay stripping on outside of peds; neutral (pH 7.0); gradual, smooth boundary.

B22t—20 to 30 inches, stony clay, light yellowish brown (2.5Y 6/3) crushed, brown (10YR 4/3) on faces of peds, light olive brown (2.5Y 5/4) when moist; strong, medium, angular, blocky structure; extremely hard, extremely firm, very sticky and very plastic; few very fine roots; common very fine pores; common thick clay films; 25 percent cobbles and stones; mildly alkaline (pH 7.6); gradual, smooth boundary.

B3—30 to 39 inches, cobbly silty clay, light yellowish brown (2.5Y 6/3) crushed, olive brown (2.5Y 4/4) on faces of peds, light olive brown (2.5Y 5/5) when moist; strong, medium, subangular structure; extremely hard, very firm, sticky and very plastic; common very fine pores; common moderately thick clay films; 25 percent cobbles; strongly calcareous; moderately alkaline (pH 8.2); gradual, wavy boundary.

C1—39 to 51 inches, light yellowish-brown (2.5Y 6/4) stony silty clay, light olive brown (2.5Y 5/4) when moist; moderate, medium, subangular blocky structure; extremely hard, very firm, sticky and plastic; common very fine pores; few moderately thick clay films; 40 percent cobbles and stones; strongly calcareous; moderately alkaline (pH 8.2); gradual, wavy boundary.

C2—51 to 60 inches, pale-yellow (2.5Y 7/4) stony light sandy clay loam, light olive brown (2.5Y 5/4) when moist; massive; very hard, firm, slightly sticky and plastic; 40 percent cobbles and stones; strongly calcareous; moderately alkaline (pH 8.4).

The A horizon is 6 to 14 inches thick. It is brown, dark grayish brown, or grayish brown when dry, and dark brown, very dark brown, or very dark grayish brown when moist. The A horizon ranges from silt loam to silty clay loam. Reaction is slightly acid to neutral.

The B2t horizon is 12 to 40 inches thick. It is light yellowish brown, grayish brown, brown, or light olive brown to light brownish gray or pale brown when dry and light olive brown, dark grayish brown, brown, or olive brown to grayish brown when moist. The B2t horizon ranges from clay to stony clay to silty clay or stony silty clay. Content of cobbles or stones is as much as 35 percent. Reaction is neutral to mildly alkaline.

The C horizon is light yellowish brown, grayish brown, brown, or light olive brown to light gray, very pale brown,

or pale yellow when dry and light olive brown, grayish brown, dark grayish brown, or olive brown when moist. The C horizon is strongly calcareous, and reaction is mildly alkaline to moderately alkaline.

In most places in the Sanpete Area, the content of rock fragments is 15 to 35 percent and consists mainly of stones in the B horizon, which is not typical of the Gothic series. This, however, does not alter the management or usefulness of the soils for range.

GOF2—Gothic stony loam, 25 to 40 percent slopes, eroded. This soil is on mountainsides. Runoff is medium, and the hazard of erosion is moderate. Sheet and rill erosion are active, and there are some deep gullies. Erosion has removed the surface layer and uncovered stones formerly buried, and now stones and cobbles cover 2 to 10 percent of the surface.

Included with this soil in mapping are small areas of Skylick silt loam, 4 to 30 percent slopes.

This soil is used as summer range by sheep, cattle, deer, and elk. It is valuable as a water catchment area for watersheds and for esthetic purposes. Capability unit VIe-H nonirrigated; High Mountain Loam range site.

Green River Series

The Green River series consists of moderately well drained soils that formed in alluvium derived from sandstone, shale, and limestone on flood plains and alluvial fans. Green River soils are commonly associated with Anco, Genola, Poganeab, and Woodrow soils. Slope is 0 to 3 percent.

Elevation ranges from 5,200 to 5,600 feet. The average annual precipitation ranges from 8 to 11 inches, and the mean annual air temperature ranges from 47° to 49° F. The frost-free period is 110 to 120 days. Vegetation is Kentucky bluegrass, big rabbit-brush, and willows.

In a representative profile the surface layer is light brownish-gray loam about 6 inches thick. The substratum to a depth of 60 inches is stratified light brownish-gray, very pale brown, and light-gray loam, silt loam, loamy sand, and clay loam.

The Green River soils are strongly calcareous, and reaction is moderately alkaline to strongly alkaline. Permeability is moderate. The available water capacity is 6 to 8 inches. The effective root zone is 60 inches or more. The seasonal water table fluctuates between depths of 30 and 60 inches.

Green River soils are used for irrigated alfalfa, small grain, and pasture. They are also used for native grass pasture and hay and as habitat by upland game birds.

Representative profile of Green River loam in a cultivated field, 3 miles south of Moroni, about 1,650 feet south and 495 feet west of the northeast corner of sec. 28, T. 15 S., R. 3 E., Sanpete County:

Ap—0 to 6 inches, light brownish-gray (10YR 6/2) loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; hard, friable, slightly sticky and slightly plastic; common fine and very fine roots; few fine pores; strongly calcareous; moderately alkaline (pH 8.0); clear, smooth boundary.

C1—6 to 17 inches, light brownish-gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) when moist; weak, medium, subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few very fine roots;

common fine pores; strongly calcareous; moderately alkaline (pH 8.0); abrupt, smooth boundary.

C2—17 to 22 inches, light brownish-gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) when moist; massive; hard, friable, slightly sticky and plastic; few very fine roots; common very fine and few fine pores; strongly calcareous; moderately alkaline (pH 8.0); clear, wavy boundary.

C3—22 to 36 inches, very pale brown (10YR 7/3) loamy sand, brown (10YR 5/3) when moist; few, medium and fine, yellowish-brown (10YR 4/4) mottles; single grained; loose; few very fine roots; moderately calcareous; moderately alkaline (pH 7.8); gradual, smooth boundary.

C4—36 to 40 inches, light brownish-gray (10YR 6/2) clay loam, dark grayish brown (10YR 4/2) when moist; many fine, distinct, dark-brown (7.5YR 4/4) mottles; weak, medium, platy structure; very hard, very firm, sticky and very plastic; strongly calcareous; moderately alkaline (pH 8.0); gradual, smooth boundary.

C5—40 to 60 inches, light-gray (10YR 7/2) silt loam, dark grayish brown (10YR 4/2) when moist; many, fine, distinct, dark yellowish-brown (10YR 4/4) mottles; massive; hard, firm, sticky and plastic; strongly calcareous; moderately alkaline (pH 8.0).

Depth to mottling is 20 to 40 inches. Texture between depths of 10 and 40 inches averages fine sandy loam but is stratified and ranges from silt loam, loam, clay loam, or very fine sandy loam to loamy sand in individual layers.

The A horizon is 6 to 11 inches thick. It is light brownish gray, grayish brown, brown, or pale brown when dry and very dark grayish brown or dark brown to dark grayish brown or brown when moist. The A horizon ranges from loam to sandy loam.

The C horizon is light brownish gray, light gray, light brown, or pale brown to pinkish gray, pink, or very pale brown when dry and dark grayish brown or dark brown to brown or grayish brown when moist. The C horizon ranges from loamy sand to clay below a depth of 40 inches.

Gr—Green River loam. This soil is on flood plains and alluvial fans. Slope is 0 to 3 percent. Runoff is slow, and the hazard of erosion is slight.

Included with this soil in mapping are small areas of Anco silty clay loam; Poganeab silt loam; and Genola loam, 0 to 2 percent slopes.

This soil is used mainly for irrigated alfalfa and pasture. Small areas are used for native grass pasture and hay. It is also used as habitat by upland game birds. Capability units IIIw-2 irrigated, VIw-2 non-irrigated; Semi-wet Meadows range site.

Gullied Land

Gu—Gullied land is so eroded that it consists mainly of a network of gullies that drain into a main large gully. The gullies are 5 to 15 feet deep and are 50 to 200 feet apart.

Gullied land is used by wildlife and provides drainage outlets for adjacent soils. Capability unit VIIIE-E nonirrigated; range site not assigned.

Harding Series

The Harding series consists of well-drained soils that formed in alluvium derived from shale, sandstone, and limestone on alluvial fans, alluvial plains, and lake terraces. Harding soils are most commonly associated with Manassa, Mellor, and Sanpete soils. Slopes are typically smooth and are 1 to 5 percent.

Elevation ranges from 5,100 to 5,600 feet. The average annual precipitation ranges from 8 to 12

inches, and the mean annual air temperature ranges from 47° to 50° F. The frost-free period ranges from 115 to 130 days. Vegetation is dominantly greasewood, shadscale, and cheatgrass.

In a representative profile the surface layer is very pale brown and light-gray silt loam about 3 inches thick. The subsoil is pale-brown, very pale brown, and light-gray silty clay about 17 inches thick. The substratum is very pale brown and light-gray light silty clay and silty clay loam to a depth of 60 inches.

The Harding soils are strongly calcareous to very strongly calcareous and strongly saline. Reaction is strongly alkaline to very strongly alkaline. Permeability is slow. The available water capacity is 2 to 3 inches. The high salt content reduces the amount of water available to plants. The water-supplying capacity is less than 4 inches annually. The effective root zone is 60 inches or more.

Harding soils are used as range and as habitat by upland game birds.

Representative profile of Harding silt loam, in a range area, 3 miles west of Manti, 1 mile north of the Gunnison Reservoir, about 427 feet west, 610 feet north of the southeast corner of sec. 4, T. 18 S., R. 2 E., Sanpete County:

A21—0 to 2 inches, very pale brown (10YR 7/3) silt loam, brown (10YR 5/3) when moist; weak, thick, platy structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; common very fine vesicular pores; strongly calcareous; strongly alkaline (pH 8.8); abrupt, smooth boundary.

A22—2 to 3 inches, light-gray (10YR 7/2) silt loam, brown (10YR 5/3) when moist; moderate, thin, platy structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; few fine and very fine pores; strongly calcareous; strongly alkaline (pH 8.8); abrupt, smooth boundary.

B21t—3 to 9 inches, pale-brown (10YR 6/3) silty clay, dark yellowish brown (10YR 4/4) when moist; moderate, coarse, prismatic structure parting to moderate, medium, angular blocky; very hard, firm, sticky and very plastic; few very fine and fine roots; common very fine pores; common, moderately thick clay films on faces of peds; strongly calcareous; very strongly alkaline (pH 9.6); clear, smooth boundary.

B22tca—9 to 15 inches, very pale brown (10YR 7/3) silty clay, brown (10YR 5/3) when moist; weak, coarse, angular blocky structure parting to moderate, medium, angular blocky; very hard, firm, sticky and very plastic; common fine and very fine roots; few very fine pores; common thin clay films on faces of peds and in pores; strongly calcareous, lime in fine soft rounded masses; very strongly alkaline (pH 9.6); clear, smooth boundary.

B3ca—15 to 20 inches, light-gray (10YR 7/2) silty clay, brown (10YR 5/3) when moist; moderate, coarse, sub-angular blocky structure; very hard, firm, sticky and very plastic; few fine, medium and coarse roots; common fine, medium, and very fine pores; few thin clay films in pores; strongly calcareous, lime in fine soft rounded masses; very strongly alkaline (pH 9.6); clear, smooth boundary.

C1—20 to 33 inches, very pale brown (10YR 7/3) light silty clay, brown (10YR 5/3) when moist; massive; very hard, firm, sticky and very plastic; few very fine and medium roots; common very fine and fine pores; strongly calcareous; very strongly alkaline (pH 9.6); clear, smooth boundary.

C2—33 to 44 inches, very pale brown (10YR 7/3) silty clay loam, dark yellowish brown (10YR 4/4) when moist; massive; slightly hard, firm, sticky and plastic; few very fine, fine and medium roots; common very fine

and few fine pores; strongly calcareous; very strongly alkaline (pH 9.6); clear, smooth boundary.

C3—44 to 55 inches, light-gray (10YR 7/2) light silty clay loam, brown (10YR 5/3) when moist; massive; slightly hard, firm, sticky and plastic; few fine and very fine roots; few fine and very fine pores; strongly calcareous; very strongly alkaline (pH 9.6); gradual, smooth boundary.

C4—55 to 60 inches, very pale brown (10YR 7/3) silty clay loam, brown (10YR 5/3) when moist; massive; slightly hard, firm, sticky and plastic; few very fine roots; few very fine pores; strongly calcareous; very strongly alkaline (pH 9.6).

The A2 horizon is 2 to 10 inches thick. It is very pale brown or light gray to white when dry and brown, dark yellowish brown, or grayish brown to pale brown when moist. The A2 horizon ranges from silt loam to light silty clay loam and from nonsaline to moderately saline.

The B2t horizon is 4 to 15 inches thick. It is very pale brown, light brown, pale brown, or brown to pink when dry and brown, dark yellowish brown, or dark brown to grayish brown when moist. The B2t horizon is silty clay or clay and is moderately saline to strongly saline. Reaction is strongly alkaline to very strongly alkaline.

The C horizon is very pale brown, light brown, or light gray to pink when dry and brown, dark brown, or dark yellowish brown to grayish brown when moist. It ranges from very fine sandy loam to silty clay. Salinity in the C horizon ranges from strong to very strong and generally increases as depth increases. Reaction ranges from strongly alkaline to very strongly alkaline.

Ha—Harding silt loam. This soil is on alluvial fans, lake terraces, and flood plains. Runoff is medium, and the hazard of erosion is moderate. Sheet and rill erosion are moderate, and there are a few deep gullies in some places.

Included with this soil in mapping are small areas of Mellor silt loam and Manassa silt loam, 1 to 5 percent slopes.

Most of the acreage of this soil is used as range. Capability unit VII-S8 nonirrigated; Semi-desert Alkali Flats range site.

Harkers Series

The Harkers series consists of well-drained soils that formed in alluvium or colluvium derived from sandstone or intermediate igneous and quartzite rocks on mountainsides. Harkers soils are commonly associated with Deer Creek, Wallsburg, and Yeates Hollow soils. Slope is 6 to 40 percent.

Elevation ranges from 6,400 to 7,500 feet. The average annual precipitation ranges from 20 to 25 inches, and the mean annual air temperature ranges from 40° to 45° F. The frost-free period is 80 to 90 days. Vegetation is oakbrush, snowberry, big sagebrush, serviceberry, and slender wheatgrass.

In a representative profile the surface layer is very dark grayish-brown and dark grayish-brown silt loam and cobbly silt loam about 12 inches thick. The subsoil is brown and light-brown cobbly clay about 32 inches thick. The substratum is pale-brown cobbly clay loam to a depth of 60 inches.

Reaction is slightly acid to neutral. Permeability is slow. The available water capacity is 7 to 9 inches. Water-supplying capacity of nonirrigated soils is 12 to 16 inches annually. The effective root zone is 60 inches or more.

Harkers soils are used as summer and early fall

range by sheep, cattle, deer, and elk. They are also used as water catchment areas for watershed.

Representative profile of Harkers silt loam, 6 to 25 percent slopes, in a range area, 5 miles west of Indianola, about 1,980 feet north and 1,485 feet east of the southwest corner of sec. 11, T. 12 S., R. 3 E., Sanpete County:

A11—0 to 4 inches, very dark grayish-brown (10YR 3/2) silt loam, very dark brown (10YR 2/2) when moist; moderate, fine, granular structure; soft, very friable, nonsticky and slightly plastic; many very fine roots; few fine pores; neutral (pH 6.6); clear, smooth boundary.

A12—4 to 12 inches, dark grayish-brown (10YR 4/2) cobbly silt loam, very dark brown (10YR 2/2) when moist; weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few medium, fine, and very fine roots; common fine pores; 25 percent cobbles, gravel, or stones; neutral (pH 6.8); gradual, smooth boundary.

B21t—12 to 22 inches, brown (7.5YR 5/4) cobbly clay, dark brown (7.5YR 4/4) when moist; strong, medium, angular blocky structure; extremely hard, very firm, very sticky and very plastic; few coarse, medium, and fine roots; few fine pores; common thick clay films; 30 percent cobbles; slightly acid (pH 6.4); gradual, wavy boundary.

B22t—22 to 32 inches, light-brown (7.5YR 6/4) cobbly clay, dark brown (7.5YR 4/4) when moist; strong, medium, angular blocky structure; extremely hard, very firm, very sticky and very plastic; few medium and fine roots; few fine pores; common moderately thick clay films; 30 percent cobbles, gravel, and stones; slightly acid (pH 6.4); gradual, wavy boundary.

B3—32 to 44 inches, light-brown (7.5YR 6/4) cobbly light clay, dark brown (7.5YR 4/4) when moist; strong, fine, angular blocky structure; very hard, very firm, sticky and plastic; few fine and medium roots; few moderately thick clay film; 35 percent gravel and cobbles; slightly acid (pH 6.2); gradual, smooth boundary.

C—44 to 60 inches, pale-brown (10YR 6/3) cobbly clay loam, dark brown (7.5YR 4/3) when moist; massive; very hard, firm, sticky and plastic; few fine roots; 40 percent cobbles and gravel; slightly acid (pH 6.2).

The A horizon is 10 to 17 inches thick. It is very dark grayish brown, dark grayish brown, brown, dark brown, or grayish brown when dry and very dark brown or dark brown to very dark grayish brown when moist. It is loam or silt loam and has 10 to 25 percent cobbles and gravel.

The B horizon is 27 to 40 inches thick. The B2t horizon is brown, light brown, grayish brown, or yellowish brown to pink, pale brown, or very pale brown when dry and dark brown or very dark grayish brown to brown, grayish brown or yellowish brown when moist. The B2t horizon ranges from cobbly clay to cobbly heavy clay loam and has 20 to 35 percent cobbles and gravel.

The C horizon is cobbly or very cobbly clay loam.

HED—Harkers silt loam, 6 to 25 percent slopes. This soil is on mountainsides. It has the profile described as representative of the series. Stones or cobbles cover 2 to 10 percent of the surface in places. Runoff is medium, and the hazard of erosion is slight.

Included with this soil in mapping are small areas of Yeates Hollow stony silt loam, 20 to 40 percent slopes; Wallsburg very stony loam, 20 to 40 percent slopes; and Deer Creek stony silt loam, high rainfall, 6 to 25 percent slopes.

This soil is used as summer and early fall range by sheep, cattle, deer, and elk. It is also important as a catchment area for watersheds. Capability unit VIe-M nonirrigated; Mountain Loam (Oak) range site.

HKE—Harkers stony silt loam, 25 to 40 percent slopes. This soil is on mountainsides. It has a profile

similar to the one described as representative of the series, but stones or cobbles cover 2 to 10 percent of the surface. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Yeates Hollow stony silt loam, 20 to 40 percent slopes; Wallsburg very stony loam, 20 to 40 percent slopes; and Deer Creek stony silt loam, high rainfall, 25 to 40 percent slopes.

This soil is used as summer and early fall range by sheep, cattle, deer, and elk. It is also used as a catchment area for watersheds. Capability unit VIe-M non-irrigated; Mountain Loam (Oak) range site.

Keigley Series

The Keigley series consists of well-drained soils that formed in alluvium derived from limestone, sandstone, and shale on alluvial fans, alluvial plains, and valley bottoms. Keigley soils are commonly associated with Calita, Doyce, Moroni, and Snake Hollow soils. Slopes are typically smooth and are 2 to 4 percent.

Elevation ranges from 5,400 to 6,100 feet. The average annual precipitation ranges from 12 to 14 inches, and the mean annual air temperature ranges from 45° to 48° F. The frost-free period ranges from 110 to 130 days. Vegetation in the noncultivated areas is perennial grasses, great basin wildrye, globemallow, and rabbitbrush.

In a representative profile the surface layer is grayish-brown and brown silty clay loam about 24 inches thick. The substratum is pale-brown silty clay loam to a depth of about 37 inches and pale-brown and light brownish-gray stratified silty clay and clay to a depth of 60 inches.

The Keigley soils are moderately calcareous to strongly calcareous, and reaction is mildly alkaline to strongly alkaline. Permeability is moderately slow. The available water capacity is 8 to 12 inches. The water-supplying capacity of nonirrigated soils is 8 to 10 inches annually. The effective root zone is about 60 inches.

Keigley soils are used for irrigated and nonirrigated alfalfa, small grain, and grass for hay or pasture.

Representative profile of Keigley silty clay loam, 2 to 4 percent slopes, in a nonirrigated grass pasture, 3 miles west of Moroni near the intersection of Moroni Road and Wales-Fountain Green Road, about 330 feet east and 1,320 feet north of the southwest corner of sec. 7, T. 15 S., R. 2 E., Sanpete County:

Ap1—0 to 3 inches, grayish-brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, granular structure; hard, firm, slightly sticky and plastic; few very fine roots; few fine and very fine pores; strongly calcareous; mildly alkaline (pH 7.6); abrupt, smooth boundary.

Ap2—3 to 7 inches, brown (10YR 5/3) silty clay loam, dark brown (10YR 3/3) when moist; weak, thick, platy structure; hard, firm, slightly sticky and plastic; few very fine roots; strongly calcareous; mildly alkaline (pH 7.6); abrupt, smooth boundary.

A13—7 to 16 inches, grayish-brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, subangular blocky structure; hard, firm, sticky and plastic; few fine roots; few medium and fine pores; strongly calcareous; mildly alkaline (pH 7.8); clear, smooth boundary.

A14—16 to 24 inches, brown (10YR 5/3) silty clay loam, dark brown (10YR 3/3) when moist; weak, coarse, prismatic structure parting to moderate, fine, angular blocky; hard, firm, sticky and plastic; few very fine roots; common fine pores; strongly calcareous; moderately alkaline (pH 8.2); clear, smooth boundary.

C1—24 to 37 inches, pale-brown (10YR 6/3) silty clay loam, dark brown (10YR 4/3) when moist; moderate, fine, subangular blocky structure; very hard, very firm, sticky and plastic; few very fine roots; few fine and very fine pores; strongly calcareous; strongly alkaline (pH 8.5); clear, smooth boundary.

C2—37 to 45 inches, pale-brown (10YR 6/3) silty clay, brown (10YR 4/3) when moist; massive; very hard, very firm, very sticky and very plastic; few very fine roots; few very fine pores; very strongly calcareous, lime in veins; strongly alkaline (pH 8.6); gradual, smooth boundary.

C3—45 to 60 inches, light brownish-gray (10YR 6/2) clay, brown (10YR 4/3) when moist; massive; extremely hard, very firm, very sticky and very plastic; no visible roots; few very fine pores; strongly calcareous; strongly alkaline (pH 9.0).

Texture between depths of 10 and 40 inches averages silty clay loam, but individual layers range from silty clay loam to silty clay.

The A horizon is 20 to 30 inches thick. It is grayish brown, dark grayish brown, or brown when dry and very dark grayish brown, very dark brown, or dark brown when moist. Reaction ranges from mildly alkaline to moderately alkaline.

The C horizon is pale brown, brown or grayish brown to white when dry and dark brown, brown, or grayish brown to light brownish gray when moist. Reaction ranges from moderately alkaline to very strongly alkaline. The C horizon ranges from silt loam to clay below a depth of 40 inches.

KcB—Keigley silty clay loam, 2 to 4 percent slopes.

This soil is on alluvial fans, alluvial plains, and in valley bottoms. Runoff is medium, and the hazard of erosion is slight.

Included with this soil in mapping are small areas of Moroni silty clay, 2 to 8 percent slopes; Calita loam, 2 to 4 percent slopes; and Birdow very fine sandy loam, 2 to 4 percent slopes. Also included are small areas of Keigley silty clay loam, 4 to 8 percent slopes, and areas where the surface layer is silty clay.

Most of the acreage of this soil is used for irrigated alfalfa and irrigated or nonirrigated small grain and grass for hay or pasture. Small areas are used as range. Capability units IIe-2 irrigated, IVe-UZ nonirrigated; Upland Loam range site.

Kitchell Series

The Kitchell series consists of somewhat excessively drained soils that formed in alluvium or colluvium derived from limestone and shale on mountainsides. Kitchell soils are commonly associated with Deer Creek, Lizzant, Lundy, and Mower soils. Slope is 40 to 70 percent.

Elevation ranges from 7,000 to 8,000 feet. The average annual precipitation ranges from 20 to 22 inches, and the mean annual air temperature ranges from 40° to 43° F. The frost-free period is 70 to 90 days. Vegetation is Douglas-fir, concolor fir, oakbrush, and forbs.

In a representative profile the surface layer is very dark grayish brown gravelly loam and dark-brown very cobbly loam about 22 inches thick. The substratum to a depth of 60 inches is light brownish-gray and very pale brown very strongly calcareous very stony loam.

Permeability is moderately rapid. The available water capacity is 4 to 6 inches. The water-supplying capacity is 9 to 12 inches annually. The effective root zone is 60 inches or more.

Kitchell soils are used for woodland of Douglas-fir and concolor fir. They are also used as summer habitat by deer and elk.

Representative profile of Kitchell gravelly loam, 40 to 70 percent slopes, in a woodland area in Hells Kitchen Canyon, 2,145 feet north and 2,150 feet west of the southeast corner of sec. 16, T. 17 S., R. 1 E., Sanpete County:

- O1—1½ inches to 0, freshly fallen leaves, pine needles and other decomposing vegetative matter.
- A11—0 to 5 inches, very dark grayish-brown (10YR 3/2) gravelly loam, very dark brown (10YR 2/2) when moist; weak, fine, granular structure; slightly hard, friable, nonsticky and plastic; common fine and few very fine roots; few fine pores; 20 percent gravel; soil mass noncalcareous; moderately calcareous fine lime nodules and fine gravel; neutral (pH 7.0); clear, smooth boundary.
- A12—5 to 14 inches, very dark grayish-brown (10YR 3/2) gravelly loam, very dark brown (10YR 2/2) when moist; weak, medium, subangular blocky structure; slightly hard, friable, nonsticky and plastic; common fine and few medium and coarse roots; few very fine pores; 20 percent gravel; soil mass noncalcareous; moderately calcareous fine gravel and fine lime nodules; neutral (pH 7.0); clear, wavy boundary.
- A13—14 to 22 inches, dark-brown (7.5YR 4/2) very cobbly loam, very dark brown (10YR 2/2) when moist; weak, fine, subangular blocky structure; slightly hard, friable, slightly sticky and plastic; common fine and very fine roots; few fine discontinuous pores; 75 percent cobbles and gravel; strongly calcareous lime occurs as coatings on rock fragments and in fine nodules and gravel, soil mass is slightly calcareous; neutral (pH 7.0); clear, irregular boundary.
- C1ca—22 to 46 inches, light brownish-gray (10YR 6/2) very stony loam, dark brown (10YR 4/2) when moist; massive; slightly hard, friable, nonsticky and plastic; common fine and very fine roots and few medium and coarse roots; 75 percent rock fragments, mainly stones; very strongly calcareous, lime in fine nodules and segregated coatings on stones; moderately alkaline (pH 8.0); gradual, wavy boundary.
- C2ca—46 to 60 inches, very pale brown (10YR 7/3) very stony loam, brown (10YR 5/3) when moist; massive; soft, friable, slightly sticky and plastic; 80 percent rock fragments; very strongly calcareous, lime segregated as coatings on rock fragments and in fine nodules; moderately alkaline (pH 8.0).

Texture between depths of 10 and 40 inches ranges from gravelly or very gravelly loam to cobbly or very cobbly loam or stony and very stony loam. Content of rock fragments ranges from 35 to 80 percent.

The A horizon is 16 to 31 inches thick. It is very dark grayish brown, dark brown to brown or grayish brown when dry and very dark brown to dark brown or very dark grayish brown when moist. It is typically gravelly loam; content of gravel is 20 to 50 percent. The A horizon is noncalcareous to moderately calcareous. The soil mass is noncalcareous, and the lime is in the fine gravel. Reaction ranges from neutral to moderately alkaline.

The Cca horizon is light brownish gray, pinkish gray, light brown, or pale brown to pink or very pale brown when dry and brown, dark brown, or dark grayish brown to pink or very pale brown when moist. Colors also range to reddish brown in places. The Cca horizon is very strongly calcareous, and reaction is neutral to strongly alkaline.

KEG—Kitchell gravelly loam, 40 to 70 percent slopes. This soil is on the north-facing mountainsides. It has the profile described as representative of the series. Runoff is medium, and the hazard of erosion is moder-

ate. On Mount Stevens in Redmond Canyon this soil has a thin bleached subsurface layer. Vegetation is typically woodland.

Included with this soil in mapping are small areas of Lizzant very stony loam, 40 to 70 percent slopes; Deer Creek stony silt loam, high rainfall, 25 to 40 percent slopes; Mower clay loam, 5 to 30 percent slopes; Rock outcrop; and areas where stones cover 2 to 10 percent of the surface.

This soil is used for woodland. It is also used as wildlife habitat by deer and elk. This soil has a site index of about 65 for Douglas-fir and about 51 for concolor fir. The average annual production is about 104 board feet of sawtimber per acre for Douglas-fir and 38 board feet per acre for concolor fir. Seedling mortality, windthrow hazard, and plant competition are slight; equipment restriction is moderate to severe. Capability unit VIIs-HC nonirrigated; range site not assigned.

KM—Kitchell-Mower association. This association is on mountainsides. It is about 50 percent Kitchell gravelly loam, 40 to 70 percent slopes, on the very steep north-facing aspects; about 40 percent Mower clay loam, 5 to 30 percent slopes, in the less sloping areas; about 10 percent Lundy channery silt loam, 5 to 40 percent slopes, on the ridges; small areas of Rock outcrop; and Lizzant very cobbly loam, 20 to 40 percent slopes.

Runoff is medium on this mapping unit, and the hazard of erosion is moderate.

Kitchell soil is used for woodland of Douglas-fir, concolor fir, maple, or oakbrush. It is also used as habitat by deer. The Mower soil is used as range, mainly by sheep and deer.

This association has a site index of about 65 for Douglas-fir and about 51 for concolor fir. The average annual production is about 104 board feet of sawtimber per acre for Douglas-fir and 38 board feet per acre for concolor fir. Seedling mortality, windthrow hazard, and plant competition are slight; equipment restriction is moderate to severe. Kitchell soil in capability unit VIIs-HC nonirrigated, range site not assigned; Mower soil in capability unit VIIs-M nonirrigated, Mountain Stony Loam range site.

Kjar Series

The Kjar series consists of very poorly drained soils that formed in alluvium derived mainly from limestone on bottom lands of alluvial valleys. Kjar soils are commonly associated with Anco, Peteetneet, Poganeab, and Shumway soils. Slope is 0 to 2 percent.

Elevation ranges from 5,200 to 5,600 feet. The average annual precipitation ranges from 8 to 12 inches, and the mean annual air temperature ranges from 45° to 48° F. The frost-free period is 110 to 120 days. Vegetation is mainly water- and salt-tolerant perennial grasses.

In a representative profile the surface layer is dark-gray peaty silt loam about 8 inches thick. The substratum is light-gray and white silty clay loam to a depth of about 19 inches and light-gray and white very strongly calcareous silt loam to a depth of 60 inches.

The soils are moderately alkaline to strongly alkaline and moderately saline to strongly saline. Permeability is moderate. The available water capacity is 5 to 8 inches. The amount of water available to plants is reduced by the high content of salt. The effective root zone is 60 inches or more. The seasonal high water table fluctuates from the surface to a depth of 10 inches, but during part of the season it is as much as 60 inches deep.

Kjar soils are used for pasture or as range. They are also used as nesting sites by both upland game birds and waterfowl.

Representative profile of Kjar peaty silt loam, in a pasture about 3½ miles northwest of Manti, at a point 1,495 feet north and 200 feet east of the southwest corner of sec. 24, T. 17 S., R. 2 E., Sanpete County:

O2—8 inches to 0, dark-gray (10YR 4/1) peaty silt loam, black (10YR 3/2) when moist; massive; slightly hard, very friable, nonsticky and nonplastic; many fine and very fine roots; strongly calcareous; strongly alkaline (pH 8.6); abrupt, smooth boundary.

C1—0 to 6 inches, white (10YR 8/2) silty clay loam, light gray (10YR 7/2) when moist; few, fine, faint, yellowish-brown (10YR 5/4) mottles; weak, medium, subangular blocky structure; slightly hard, friable, sticky and plastic; few fine and very fine roots; very strongly calcareous; common snail shells; strongly alkaline (pH 9.0); abrupt, smooth boundary.

C2—6 to 11 inches, light-gray (10YR 7/2) light silty clay loam, light brownish gray (10YR 6/2) when moist; few, fine, faint, yellowish-brown (10YR 5/4) mottles; massive; slightly hard, friable, sticky and plastic; few very fine roots; few fine pores; very strongly calcareous; common freshwater snail shells; strongly alkaline (pH 8.8); clear, smooth boundary.

C3—11 to 35 inches, light-gray (10YR 8/2) silt loam, light brownish gray (10YR 6/2) when moist; 3 layers, ¼ to 1 inch thick, of silt loam that are dark gray (10YR 3/1) when moist; massive; slightly hard, friable, sticky and plastic; few very fine roots; few very fine pores; few fine gypsum crystals; very strongly calcareous; common small and medium freshwater snail shells; strongly alkaline (pH 9.0); gradual, smooth boundary.

C4—35 to 60 inches, white (10YR 8/2) silt loam, light brownish gray (10YR 6/2) when moist; ½-inch layer of dark gray (10YR 4/1) loam, very dark gray (10YR 3/1) when moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; few very fine pores; few fine gypsum flakes or crystals; very strongly calcareous; numerous freshwater snail shells; strongly alkaline (pH 9.0).

The soils are gray or light gray and have chromas of 2 or 1 within a depth of 12 inches of the peaty layer. Texture between depths of 10 and 40 inches averages silt loam but ranges from silty clay loam to silt loam.

The O2 horizon is 6 to 8 inches thick. It is dark gray to very dark gray when dry and black when moist. Content of organic matter ranges from 30 to 80 percent. The O2 horizon is moderately calcareous to strongly calcareous and moderately alkaline to strongly alkaline.

The C horizon is white to light gray or light brownish gray when dry and light brownish gray to gray or brownish gray to light gray when moist. Dark-gray or very dark gray layers ¼ to 9 inches thick are in most places.

Kp—Kjar peaty silt loam. This soil is on valley bottoms. Slope is 0 to 2 percent. Runoff is ponded, and there is no hazard of erosion.

Included with this soil in mapping are small areas of Peteetneet peat; Anco silty clay loam; Poganeab silt loam, strongly saline-alkali; Shumway silty clay loam; and small areas that do not have a peaty surface layer.

This soil is used as pasture or range. It is also used as nesting habitat by both upland game birds and waterfowl. Capability unit VIIw-28 nonirrigated; Salt Meadows range site.

Linoyer Series

The Linoyer series consists of well-drained soils that formed in alluvium derived from sandstone and limestone on alluvial fans and alluvial plains. Linoyer soils are commonly associated with Arapien, Genola, Rapho, and Woodrow soils. Slope is 1 to 5 percent.

Elevation ranges from 5,100 to 6,000 feet. The average annual precipitation ranges from 8 to 12 inches, and the mean annual air temperature ranges from 45° to 49° F. The frost-free period is 115 to 130 days. Vegetation is rabbitbrush, Indian ricegrass, and big sagebrush.

In a representative profile the surface layer is light brownish-gray and pale-brown very fine sandy loam about 7 inches thick. The substratum to a depth of 60 inches is very pale brown very fine sandy loam and silt loam.

Reaction is moderately alkaline to strongly alkaline. Permeability is moderate. The available water capacity is 8 to 11 inches. The water-supplying capacity is 5 to 8 inches annually. The effective root zone is about 60 inches.

Linoyer soils are used for irrigated alfalfa, small grain, sugar beets, corn, and pasture. They are also used as range.

Representative profile of Linoyer very fine sandy loam, 2 to 5 percent slopes, eroded, 200 yards north of Palisade Lake, 1,500 feet east and 1,000 feet south of the northwest corner of sec. 35, T. 18 S., R. 2 E., Sanpete County:

A11—0 to 2 inches, light brownish-gray (10YR 6/2) very fine sandy loam, dark grayish brown (10YR 4/2) when moist; weak, medium, platy structure; common very fine and few medium roots; few very fine pores; moderately calcareous; moderately alkaline (pH 8.2); abrupt, smooth boundary.

A12—2 to 7 inches, pale-brown (10YR 6/3) very fine sandy loam, brown (10YR 5/3) when moist; weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and few medium roots; few very fine and fine pores; moderately calcareous; moderately alkaline (pH 8.4); clear, smooth boundary.

C1—7 to 17 inches, very pale brown (10YR 7/4) very fine sandy loam, brown (10YR 5/3) when moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; few very fine and fine pores; strongly calcareous; strongly alkaline (pH 8.6); gradual, smooth boundary.

C2—17 to 34 inches, very pale brown (10YR 7/4) very fine sandy loam, yellowish brown (10YR 5/4) when moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; few very fine and fine pores; strongly calcareous; moderately alkaline (pH 8.4); clear, smooth boundary.

C3—34 to 43 inches, very pale brown (10YR 7/4) silt loam, light yellowish brown (10YR 6/4) when moist; massive; slightly hard, friable, slightly sticky and plastic; few very fine pores; strongly calcareous; moderately alkaline (pH 8.4); gradual, smooth boundary.

C4—43 to 60 inches, very pale brown (10YR 7/4) very fine sandy loam, light yellowish brown (10YR 6/4) when moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine pores; strongly calcareous; moderately alkaline (pH 8.2).

Texture between depths of 10 and 40 inches ranges from very fine sandy loam to silt loam.

The A horizon is 6 to 11 inches thick. It is light brownish gray, pale brown, pinkish gray, pink, or very pale brown when dry and dark grayish brown, brown, dark brown to grayish brown or yellowish brown when moist. The A horizon is loam, silt loam, or very fine sandy loam.

The C horizon is very pale brown, light brown, light yellowish brown, or brownish yellow to pink when dry and brown, dark brown, or light yellowish brown to dark yellowish brown or light brown or pale brown when moist. Colors also range to reddish brown or light reddish brown. Content of gravel below a depth of 40 inches ranges from 0 to 20 percent.

LdB—Linoyer very fine sandy loam, 1 to 2 percent slopes. This soil is on alluvial fans and alluvial plains. It has a profile similar to the one described as representative of the series, but it is only slightly eroded. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Linoyer very fine sandy loam, 2 to 5 percent slopes, eroded; Rapho gravelly fine sandy loam, 2 to 5 percent slopes; and Arapien fine sandy loam, 1 to 2 percent slopes.

This soil is used for irrigated alfalfa, small grain, corn, sugar beets, and pasture. Small areas are also used as range. Capability units IIe-2 irrigated, VIIe-S nonirrigated; Semi-desert Loam range site.

LdC2—Linoyer very fine sandy loam, 2 to 5 percent slopes, eroded. This soil is on alluvial fans and alluvial plains. It has the profile described as representative of the series. Runoff is medium, and the hazard of erosion is severe. Sheet erosion is moderate, and there are usually rills and a few deep gullies.

Included with this soil in mapping are small areas of Linoyer very fine sandy loam, 1 to 2 percent slopes; Genola loam, 2 to 5 percent slopes, eroded; and Arapien fine sandy loam, 2 to 5 percent slopes, eroded.

This soil is used for irrigated alfalfa, small grain, corn, and pasture. Some areas are used as range. Capability units IIIe-2 irrigated, VIIe-S nonirrigated; Semi-desert Loam range site.

Lisade Series

The Lisade series consists of somewhat excessively drained soils that formed in alluvium derived from sandstone, limestone, and shale on alluvial fans and alluvial plains. Lisade soils are commonly associated with Amtoft, Arapien, Genola, Rapho, and Sanpete soils. Slope is 1 to 5 percent.

Elevation ranges from 5,000 to 6,000 feet. The average annual precipitation ranges from 8 to 12 inches, and the mean annual air temperature ranges from 45° to 49° F. The frost-free period ranges from 115 to 130 days. Vegetation in the noncultivated areas is dominantly black sagebrush, yellowbrush, rabbitbrush, and Indian ricegrass.

In a representative profile the surface layer is pinkish-gray and light-brown loam about 5 inches thick. The substratum is pinkish-white and pink sandy loam, loam, and gravelly sandy loam to a depth of about 34 inches and pink and light-brown gravelly sandy loam and gravelly loam to a depth of 66 inches.

The Lisade soils are strongly calcareous in the sur-

face layer, very strongly calcareous in the upper part of the substratum, and strongly calcareous in the lower part of the substratum. Reaction is moderately alkaline to strongly alkaline. Permeability is moderately rapid. The available water capacity is 5 to 7 inches. The water-supplying capacity of nonirrigated soils is 5 to 8 inches annually. The effective root zone is about 60 inches.

Lisade soils are used for irrigated alfalfa, small grain, corn silage, improved pasture, and range. These soils are also used as habitat by upland game birds and rabbits.

Representative profile of Lisade loam, 2 to 5 percent slopes, eroded, in a range area 2 miles east, ¼ mile north of Axtell, east side of Highland Canal, about 3,000 feet east and 1,070 feet south of the northwest corner of sec. 15, T. 20 S., R. 1 E., Sanpete County:

A11—0 to 2 inches, pinkish-gray (7.5YR 6/2) loam, brown (7.5YR 5/3) when moist; weak, thick, platy structure; slightly hard, very friable, slightly sticky and slightly plastic; few medium and common fine roots; common fine pores; 15 percent gravel, mainly a surface mantle; strongly calcareous; moderately alkaline (pH 8.4); clear, smooth boundary.

A12—2 to 5 inches, light-brown (7.5YR 6/4) loam, brown (7.5YR 5/4) when moist; weak, fine, subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine and medium roots; strongly calcareous, lime in veins; strongly alkaline (pH 8.5); clear, smooth boundary.

C1ca—5 to 12 inches, pinkish-white (7.5YR 8/2) loam, pink (7.5YR 7/4) when moist; weak, medium, platy structure; slightly hard, friable, slightly sticky and slightly plastic; common fine and medium roots; common fine and very fine pores; very strongly calcareous, lime in soft rounded masses and flakes; strongly alkaline (pH 8.6); gradual, smooth boundary.

C2ca—12 to 16 inches, pinkish-white (7.5YR 8/2) sandy loam, pink (7.5YR 7/4) when moist; weak, medium, platy structure; slightly hard, very friable, nonsticky and nonplastic; common fine and very fine and few medium roots; common very fine pores; very strongly calcareous, lime in soft rounded masses and flakes; strongly alkaline (pH 8.6); gradual, smooth boundary.

C3ca—16 to 22 inches, pink (7.5YR 7/4) sandy loam, light brown (7.5YR 6/4) when moist; massive; hard, friable, slightly sticky and slightly plastic; few fine roots; common very fine pores; about 15 percent gravel; very strongly calcareous, coatings on gravel and in soft rounded masses; strongly alkaline (pH 8.5); clear, smooth boundary.

C4ca—22 to 34 inches, pink (7.5YR 7/4) gravelly sandy loam, light brown (7.5YR 6/4) when moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; few fine pores; 20 percent fine gravel; very strongly calcareous, lime in fine soft rounded masses and flakes; strongly alkaline (pH 8.7); clear, wavy boundary.

C5—34 to 55 inches, light-brown (7.5YR 6/4) gravelly sandy loam, reddish brown (5YR 5/4) when moist; massive; slightly hard, very friable, nonsticky and slightly plastic; few fine roots; common very fine pores; about 20 percent fine gravel; strongly calcareous, lime in soft rounded masses; strongly alkaline (pH 8.8); clear, wavy boundary.

C6—55 to 66 inches, pink (5YR 7/4) gravelly loam, yellowish red (5YR 5/6) when moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; few fine roots; few fine and very fine pores; about 30 percent gravel; strongly calcareous, lime segregated on gravel; strongly alkaline (pH 8.8).

Texture between depths of 10 and 40 inches is typically gravelly sandy loam but ranges to fine sandy loam and loam. Rock fragments are mainly gravel, and content ranges from 10 to 35 percent.

The A horizon is 5 to 14 inches thick. It is light brown to pink, pinkish gray, or very pale brown when dry and dark brown to brown or grayish brown when moist. The A horizon is fine sandy loam or loam.

The Cca horizon is pinkish white, pink, light brown, or light brownish gray to very pale brown when dry and pink, brown, light brown, reddish brown, or grayish brown to very pale brown when moist. It is 29 to 46 inches thick. The C horizon has color and texture similar to the Cca horizon, but it contains less lime, and content of gravel is 20 to 50 percent.

LeB—Lisade loam, 1 to 2 percent slopes. This soil is on alluvial fans and alluvial plains. It has a profile similar to the one described as representative of the series, but the surface layer is 10 to 14 inches thick. Runoff is slow, and the hazard of erosion is moderate. Sheet erosion and rill erosion are active in places.

Included with this soil in mapping are small areas of Arapien fine sandy loam, 1 to 2 percent slopes; Sanpete gravelly fine sandy loam, 2 to 5 percent slopes; and Linoyer very fine sandy loam, 1 to 2 percent slopes.

Most of the acreage of this soil is used for irrigated alfalfa, small grain, corn silage, and pasture. Small areas are used as range. Capability units IIe-2 irrigated, VIIe-S nonirrigated; Semi-desert Limy Loam range site.

LeC2—Lisade loam, 2 to 5 percent slopes, eroded. This soil is on alluvial fans and alluvial plains. It has the profile described as representative of the series. Runoff is medium, and the hazard of erosion is severe. There are a few deep gullies, and sheet erosion and rill erosion are common. The surface layer is only 5 to 10 inches thick, and white spots show where the original surface layer has been removed. In places, a thin mantle of gravel is on the surface. East of Axtel this soil has some gypsum crystals below a depth of 30 inches.

Included with this soil in mapping are small areas of Arapien fine sandy loam, 2 to 5 percent slopes, eroded; Sanpete gravelly fine sandy loam, 2 to 5 percent slopes; Sanpete cobbly fine sandy loam, 5 to 10 percent slopes, eroded; and Linoyer very fine sandy loam, 2 to 5 percent slopes, eroded. The Sanpete soils are on the low ridges east of Axtel.

Most of the acreage of this soil is used as range. In some areas small acreages are used for irrigated alfalfa and small grain. Capability units IIIe-2 irrigated, VIIe-S nonirrigated; Semi-desert Limy Loam range site.

LFC2—Lisade-Sanpete complex, 2 to 5 percent slopes, eroded. This mapping unit is on alluvial fans. It is about 55 percent Lisade loam, 2 to 5 percent slopes, eroded, in the swales, depressions, and less sloping areas; about 35 percent Sanpete gravelly fine sandy loam, 2 to 5 percent slopes, on the ridges and steeper side slopes; small areas of Denmark gravelly loam, 2 to 5 percent slopes; Arapien fine sandy loam, 2 to 5 percent slopes, eroded; and Rapho gravelly fine sandy loam, 2 to 5 percent slopes.

Runoff is medium on the Lisade loam, and the hazard of erosion is severe. There are a few deep gullies, and sheet erosion and rill erosion are common. The surface layer is 5 to 10 inches thick, and white spots indicate where the original surface layer has been removed. There usually is a thin mantle of gravel on the sur-

face. Runoff is medium on the Sanpete gravelly fine sandy loam, and the hazard of erosion is moderate.

This mapping unit is used as spring and fall range by sheep and cattle. Capability unit VIIe-S nonirrigated; Lisade soil in Semi-desert Limy Loam range site, Sanpete soil in Semi-desert Stony Loam range site.

Lizzant Series

The Lizzant series consists of somewhat excessively drained soils that formed in alluvium and colluvium derived from limestone, sandstone, and shale on mountainsides and alluvial fans. Lizzant soils are commonly associated with Clegg, Fontreen, Mower, and Sedwell soils. Slope is 4 to 60 percent.

Elevation ranges from 6,800 to 8,000 feet. The average annual precipitation ranges from 14 to 20 inches, and the mean annual air temperature ranges from 43° to 45° F. The frost-free period is 90 to 110 days. Vegetation is oakbrush, snowberry, birchleaf mountainmahogany, and perennial grasses.

In a representative profile the surface layer is very dark grayish-brown and dark grayish-brown very cobbly loam and cobbly loam about 11 inches thick. The subsoil is grayish-brown very strongly calcareous cobbly loam about 9 inches thick. The substratum to a depth of about 60 inches is light brownish-gray very gravelly loam and very stony clay loam.

The Lizzant soils are slightly calcareous to strongly calcareous in the surface layer and very strongly calcareous in the subsoil and substratum. Permeability is moderately rapid. The available water capacity is 4 to 6 inches. The water-supplying capacity is 6 to 10 inches annually. The effective root zone is 60 inches or more.

Lizzant soils are used as range by sheep, cattle, deer, and elk. They are a fair source of road fill.

Representative profile of Lizzant very cobbly loam, 20 to 40 percent slopes, in a range area about ¼ mile east of the upper power plant in Fairview Canyon, about 2,000 feet south and 1,000 feet west of the northeast corner of sec. 31, T. 13 S., R. 5 E., Sanpete County:

A11—0 to 5 inches, very dark grayish-brown (10YR 3/2) very cobbly loam, very dark brown (10YR 2/2) when moist; moderate, fine, granular structure; soft, friable, slightly sticky and slightly plastic; common very fine roots; few medium and fine pores; 50 percent cobbles and stones, mainly as a surface mantle; strongly calcareous, lime is in fine limestone fragments, the soil matrix is slightly calcareous; moderately alkaline (pH 8.4); clear, smooth boundary.

A12—5 to 11 inches, dark grayish-brown (10YR 4/2) cobbly loam, very dark brown (10YR 2/2) when moist; moderate, fine, granular structure; soft, friable, slightly sticky and plastic; few medium and common very fine roots; few fine and medium pores; 20 percent cobbles and 15 percent gravel, dominantly limestone; strongly calcareous, lime is disseminated and in fine limestone fragments, moderately alkaline (pH 8.4); clear, smooth boundary.

B2—11 to 20 inches, grayish-brown (10YR 5/2) cobbly loam, dark grayish brown (10YR 4/2) when moist; moderate, fine, subangular blocky structure; hard, friable, slightly sticky and plastic; few coarse, medium, fine, and very fine roots; few fine pores; 20 percent cobbles and 20 percent gravel; very strongly calcareous, lime is disseminated and in fine limestone fragments; moderately alkaline (pH 8.4); gradual, wavy boundary.

- C1ca**—20 to 32 inches, light brownish-gray (10YR 6/2) very gravelly loam, dark grayish brown (10YR 4/2) when moist; massive; slightly hard, friable, slightly sticky and plastic; few medium, fine, and very fine roots; few fine pores; 30 percent gravel and 20 percent cobbles, dominantly limestone; very strongly calcareous, thick lime coatings on rock fragments and in veins; strongly alkaline (pH 8.6); clear, smooth boundary.
- C2ca**—32 to 40 inches, light brownish-gray (10YR 6/2) very gravelly loam, dark grayish brown (10YR 4/2) when moist; massive; slightly hard, friable, slightly sticky and plastic; few fine and medium roots; 60 percent gravel and 20 percent cobbles; very strongly calcareous, lime coatings on rock fragments; strongly alkaline (pH 9.0); gradual, wavy boundary.
- C3ca**—40 to 53 inches, light brownish-gray (10YR 6/2) very stony loam, grayish brown (10YR 5/2) when moist; massive; slightly hard, firm, slightly sticky and plastic; 60 percent stones and cobbles and 10 percent gravel; very strongly calcareous, thick lime coatings on rock fragments; strongly alkaline (pH 8.8); gradual, smooth boundary.
- C4**—53 to 60 inches, light brownish-gray (10YR 6/2) very stony light clay loam, grayish brown (10YR 5/2) when moist; massive; slightly hard, firm, slightly sticky and plastic; 50 percent stones and 25 percent gravel; very strongly calcareous; moderately alkaline (pH 8.4).

Texture between depths of 10 and 40 inches ranges from gravelly or very gravelly loam to cobbly or very cobbly loam and stony or very stony loam. Content of rock fragments is 35 to 80 percent.

The A horizon is 8 to 15 inches thick. It is dark grayish brown, very dark grayish brown, brown, or grayish brown when dry and very dark brown, dark brown, or very dark grayish brown when moist. Reaction ranges from mildly alkaline to moderately alkaline, and the A horizon is slightly calcareous to strongly calcareous.

The B horizon is 4 to 14 inches thick. It is grayish brown, brown, or light brownish gray to pale brown when dry and dark grayish brown or dark brown to grayish brown or brown when moist. Reaction is moderately alkaline to strongly alkaline.

The Cca horizon is light brownish gray or pale brown to light gray or very pale brown when dry and dark grayish brown, dark brown, grayish brown, light gray, or very pale brown when moist. Reaction is moderately alkaline to strongly alkaline.

LGE—Lizzant very cobbly loam, 20 to 40 percent slopes. This soil is on mountainsides. It has the profile described as representative of the series. The surface layer has 50 percent cobbles and stones, mainly as a surface mantle. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Fontreen very cobbly loam, 20 to 40 percent slopes, eroded; Lundy channery silt loam, 5 to 40 percent slopes; and small areas that have only 10 to 25 percent of the surface covered with stones and cobbles.

This soil is used as summer range by sheep, cattle, and deer. Except for the steeper areas, it is a fair source of road fill. Capability unit VIs-M nonirrigated; Mountain Stony Loam range site.

LHD—Lizzant stony loam, 4 to 20 percent slopes. This soil is on alluvial fans. It has a profile similar to the one described as representative of the series, but stones cover about 2 percent of the surface. Runoff is medium, and the hazard of erosion is slight.

Included with this soil in mapping are small areas of Fontreen cobbly loam, 4 to 20 percent slopes; Deer Creek stony silt loam, 6 to 30 percent slopes; and small areas that have 10 to 25 percent of the surface covered with stones and cobbles.

This soil is used as summer range by sheep, cattle, and deer. It is a fair source of road fill. Capability unit VIs-M nonirrigated; Mountain Stony Loam range site.

LKG—Lizzant very stony loam, 40 to 60 percent slopes. This soil is on mountainsides. It has a profile similar to the one described as representative of the series, but it has 40 to 60 percent slopes, and stones and cobbles cover 10 to 25 percent of the surface. Runoff is rapid, and the hazard of erosion is severe. The A1 horizon is only 6 to 8 inches thick in places.

Included with this soil in mapping are small areas of Kitchell gravelly loam, 40 to 70 percent slopes; Lundy channery silt loam, 5 to 40 percent slopes; and small areas that have less than 10 percent stones on the surface.

This soil is used as summer range by sheep, cattle, and deer. Capability unit VIIs-M nonirrigated; Mountain Stony Loam range site.

LLE—Lizzant-Clegg complex, 3 to 40 percent slopes. This mapping unit is on alluvial fans and mountainsides. It is about 45 percent Lizzant very cobbly loam, 20 to 40 percent slopes, on ridges and southern exposures; about 40 percent Clegg loam, 3 to 10 percent slopes, in depressions, swales, and pockets; and about 5 percent each Ant Flat stony loam, 8 to 25 percent slopes, Deer Creek stony silt loam, high rainfall, 6 to 25 percent slopes, and Lizzant stony loam, 4 to 20 percent slopes.

Runoff is medium, and the hazard of erosion is moderate.

This mapping unit is used as summer range by sheep, cattle, and deer. Capability unit VIs-M nonirrigated; Lizzant soils in Mountain Stony Loam range site; Clegg soils in Mountain Loam range site.

LMF—Lizzant-Mower complex, 25 to 60 percent slopes. This mapping unit is on mountainsides on all exposures except northern. It is about 60 percent Lizzant very stony loam, 40 to 60 percent slopes, on the upper two-thirds of the slopes; about 30 percent Mower very stony loam, 25 to 50 percent slopes, eroded, on the lower part or middle part of mountainsides and on points and ridges; and about 5 percent each Rock outcrop and Mower stony clay loam, 5 to 30 percent slopes. Also included are small areas of Lundy channery silt loam, 5 to 40 percent slopes, on ridges.

Lizzant very stony loam has a profile similar to the one described as representative of the Lizzant series, but stones and cobbles cover 10 to 25 percent of the surface and the surface layer is only 6 to 8 inches thick in places. Runoff is rapid, and the hazard of erosion is high.

Mower very stony loam, 25 to 50 percent slopes, eroded, has a profile similar to the one described as representative of the Mower series, but the surface layer is very stony loam or very stony silt loam. Runoff is medium, and the hazard of erosion is severe. Vegetation is dominantly manzanita.

This mapping unit is used as summer range by sheep, cattle, and deer. Capability unit VIIs-M nonirrigated; Mountain Stony Loam range site.

LNE—Lizzant-Sedwell complex, 5 to 40 percent slopes. This mapping unit is on alluvial fans and mountainsides. It is about 40 percent Lizzant very cobbly loam, 20 to 40 percent slopes, on ridges, the steeper

side slopes, and southern exposures; about 35 percent Sedwell silt loam, 8 to 25 percent slopes, in swales, depressions, and on the less steep side slopes; about 20 percent Mower stony clay loam, 5 to 30 percent slopes, in open sagebrush park areas; and small areas of Rock outcrop and Clegg loam, 3 to 10 percent slopes. Vegetation on the Sedwell soil is typically a heavy cover of oakbrush.

Runoff is medium, and the hazard of erosion is moderate.

Mower stony clay loam, 5 to 30 percent slopes, has a profile similar to the one described as representative of the Mower series, but stones cover 2 to 10 percent of the surface.

This mapping unit is used as spring and summer range by sheep, cattle, and deer. Capability unit VI_s-M nonirrigated; Lizzant soil in Mountain Stony Loam range site, Sedwell soil in Mountain Loam (Oak) range site.

LOF—Lizzant-Kitchell association, steep. This mapping unit is on mountainsides. It is about 40 percent Lizzant very stony loam, 40 to 60 percent slopes, dominantly on western and northern exposures, and about 40 percent Kitchell gravelly loam, 40 to 70 percent slopes, on the northern and eastern exposures. These soils occur in fairly large bodies. The remaining 20 percent of this association is Lundy channery silt loam, 5 to 40 percent slopes, on the ridges, and small areas of limestone and shale Rock outcrop.

Lizzant very stony loam, 40 to 60 percent slopes, has a profile similar to the one described as representative of the Lizzant series, but stones and cobbles cover 10 to 25 percent of the surface, and the surface layer is only 6 to 8 inches thick in places. Runoff is rapid, and the hazard of erosion is severe. Runoff on the Kitchell soils is medium, and the hazard of erosion is moderate.

Lizzant very stony loam is used as summer range by sheep, cattle, and deer. Kitchell gravelly loam is used mainly as woodland of Douglas-fir and concolor fir. It is also used by deer and elk as summer habitat.

This soil has a site index of about 65 for Douglas-fir, and a site index of about 51 for concolor fir. The average annual production is about 104 board feet of sawtimber per acre for Douglas-fir and 38 for concolor fir. Seedling mortality, windthrow hazard, and plant competition are slight; equipment restriction is moderate to severe. Lizzant soil in capability unit VII_s-M nonirrigated, Mountain Stony Loam range site; Kitchell soil in capability unit VII_s-HC nonirrigated, range site not assigned.

Lodar Series

The Lodar series consists of somewhat excessively drained soils that are 10 to 20 inches deep over limestone bedrock. These soils formed in colluvium, residuum, and local alluvium derived from limestone on mountainsides and ridges. Lodar soils are commonly associated with Atepic, Borvant, and Fontreen soils. Slope is 8 to 70 percent.

Elevation ranges from 5,600 to 6,500 feet. The average annual precipitation ranges from 12 to 14 inches, and the mean annual air temperature ranges from 43° to 45° F. The frost-free period is 90 to 110 days. Vegetation is juniper, pinon, sagebrush, and perennial

grasses.

In a representative profile the surface layer is grayish-brown very channery loam about 8 inches thick. The substratum is light-brown very strongly calcareous very gravelly loam about 7 inches thick. Limestone bedrock is at a depth of 15 inches.

Permeability is moderately rapid. The available water capacity is 1 to 2 inches. The water-supplying capacity is 3 to 4½ inches annually. Roots penetrate to the top of the bedrock, where they spread out horizontally or enter fractures in the bedrock.

Lodar soils are used as range by sheep and cattle and as woodland.

Representative profile of Lodar very channery loam, 8 to 40 percent slopes, in a range area between Lone Cedar Road and Japs Valley, about 990 feet south and 1,150 feet east of the northwest corner of sec. 23, T. 19 S., R. 11½ W., Sanpete County:

A11—0 to 2 inches, grayish-brown (10YR 5/2) very channery loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, platy structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; common very fine pores; about 50 percent channery rock fragments, mainly a surface mantle; slightly calcareous; mildly alkaline (pH 7.8); abrupt, smooth boundary.

A12—2 to 8 inches, grayish-brown (10YR 5/2) very channery loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, subangular blocky structure; slightly hard, friable, slightly sticky and plastic; common fine and very fine roots; about 50 percent rock fragments, mainly less than 6 inches in length; moderately calcareous; mildly alkaline (pH 7.8); clear, smooth boundary.

C1ca—8 to 15 inches, light-brown (7.5YR 6/3) very gravelly loam, dark brown (7.5YR 4/3) when moist; massive; slightly hard, friable, slightly sticky and plastic; few fine and very fine roots; few fine and very fine pores; about 50 percent gravel and cobbles; very strongly calcareous, lime segregated as coatings on rock fragments and in fine veins and flakes; moderately alkaline (pH 8.0); abrupt, wavy boundary.

R—15 inches, limestone rock.

Depth to limestone bedrock is 10 to 20 inches. The soil is channery or very channery loam, gravelly or very gravelly loam or cobbly or very cobbly loam. Content of rock fragments is 35 to 80 percent.

The A horizon is 8 to 10 inches thick. It is grayish brown, dark brown, or dark grayish brown to brown when dry and very dark grayish brown, very dark brown, or dark brown when moist. The A horizon is slightly calcareous to strongly calcareous, and reaction is mildly alkaline to moderately alkaline.

The Cca horizon is light brown, brown, or grayish brown to pinkish gray or very pale brown when dry and dark brown, dark grayish brown, or brown to light brown, light brownish gray, or pale brown when moist. Reaction ranges from moderately alkaline to strongly alkaline.

LRE—Lodar very channery loam, 8 to 40 percent slopes. This soil is on mountainsides and ridges. It has the profile described as representative of the series. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Borvant cobbly loam, 8 to 25 percent slopes, eroded; Fontreen very cobbly loam, 20 to 40 percent slopes, eroded; and Rock land.

This soil is used as spring and fall range by sheep and cattle and as winter range by deer. Some areas are wooded. Juniper is harvested for cedar posts, and

both juniper and pinon are used for firewood. Capability unit VII_s-U nonirrigated; Upland Shallow Loam (Juniper-Pinon) range site.

LSG—Lodar-Fontreen complex, 40 to 70 percent slopes. This mapping unit is on mountainsides. It is about 55 percent Lodar very cobbly loam, 40 to 70 percent slopes, eroded, usually on ridges and hillsides; about 35 percent Fontreen very cobbly loam, 40 to 70 percent slopes, eroded, mainly on northern and western exposures; and the rest is small areas of Borvant cobbly loam, 8 to 25 percent slopes, eroded, and Clegg loam, 3 to 10 percent slopes, in swales and depressions.

Lodar very cobbly loam, 40 to 70 percent slopes, eroded, has a profile similar to the one described as representative of the Lodar series, but the surface layer is about 50 percent cobbles, mainly a surface mantle. Runoff is rapid, and the hazard of erosion is severe. Runoff is medium on the Fontreen soils, and the hazard of erosion is severe.

This mapping unit is used as spring and fall range by sheep and cattle and as winter range by deer. Capability unit VII_s-U nonirrigated; Lodar soil in Upland Shallow Loam (Juniper-Pinon) range site, Fontreen soil in Upland Stony Loam (Juniper-Pinon) range site.

LTE—Lodar-Rock outcrop complex, 8 to 40 percent slopes. This mapping unit is on mountainsides and ridges. It is about 70 percent Lodar very channery loam, 8 to 40 percent slopes, on the mountainsides; about 20 percent Rock outcrop mainly on the points and ridges; and small areas of Fontreen very cobbly loam, 20 to 40 percent slopes, eroded, and Borvant cobbly loam, 8 to 25 percent slopes, eroded.

Runoff is medium, and the hazard of erosion is moderate.

This mapping unit is used as spring and fall range by sheep and cattle and as winter range by deer. Capability unit VII_s-U nonirrigated; Lodar soil in Upland Shallow Loam (Juniper-Pinon) range site, Rock outcrop not assigned a range site.

LTG—Lodar-Rock outcrop complex, 40 to 70 percent slopes. This mapping unit is on mountainsides and ridges. It is about 70 percent Lodar very cobbly loam, 40 to 70 percent slopes, eroded, on the mountainsides; about 20 percent Rock outcrop mainly on the points and ridges; and small areas of Fontreen very cobbly loam, 40 to 70 percent slopes, eroded, and Borvant cobbly loam, 8 to 25 percent slopes, eroded.

The Lodar soil has a profile similar to the one described as representative of the series, but the surface layer is about 50 percent cobbles, mainly a surface mantle. Runoff is rapid, and the hazard of erosion is severe.

This mapping unit is used as spring and fall range by sheep and cattle and as winter range by deer. Capability unit VII_s-U nonirrigated; Lodar soil in Upland Shallow Loam (Juniper-Pinon) range site, Rock outcrop not assigned a range site.

Lundy Series

The Lundy series consists of somewhat excessively drained soils that are 10 to 20 inches deep over limestone bedrock. These soils formed in colluvium and residuum derived from limestone and shale on broad

ridges and mountainsides. Lundy soils are commonly associated with Clegg, Kitchell, Lizzant, and Mower soils. Slope is 5 to 40 percent.

Elevation ranges from 7,000 to 8,000 feet. The average annual precipitation ranges from 16 to 20 inches, and the mean annual air temperature is 43° to 45° F. The frost-free period is 80 to 90 days. Vegetation is big sagebrush, oakbrush, and perennial grasses.

In a representative profile the surface layer is brown channery silt loam about 4 inches thick. The substratum is brown very flaggy light clay loam about 12 inches thick. Limestone bedrock is at a depth of about 16 inches.

Permeability is moderately rapid. The available water capacity is 1 to 2 inches. The water-supplying capacity is about 6 inches annually. The effective root zone extends to the top of the bedrock. Most of the roots spread horizontally on the bedrock and enter fractures in it.

Lundy soils are used as summer range by sheep, cattle, and deer.

Representative profile of Lundy channery silt loam, 5 to 40 percent slopes, in a range site, 1 mile west of Wire Grass Spring south of Dry Fork on West Mountain, about 1,200 feet north and 200 feet west of the southeast corner of sec. 21, T. 17 S., R. 1 E., Sanpete County:

A1—0 to 4 inches, brown (10YR 4/3) channery silt loam, very dark brown (10YR 2/3) when moist; weak, fine, granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine, few fine roots; 25 percent channery limestone fragments 1 to 6 inches in length, mainly surface mantle; noncalcareous; mildly alkaline (pH 7.4); clear, smooth boundary.

C1ca—4 to 9 inches, brown (10YR 5/3) very flaggy light clay loam, dark brown (10YR 3/3) when moist; moderate, fine, subangular blocky structure; hard, firm, sticky and plastic; few fine, very fine, and medium roots; few fine and very fine pores; 75 percent rock fragments 6 to 15 inches in length; strongly calcareous; moderately alkaline (pH 8.2); gradual, smooth boundary.

C2ca—9 to 16 inches, brown (10YR 5/3) very flaggy light clay loam, dark brown (10YR 3/3) when moist; weak, fine, subangular blocky structure; hard, firm, sticky and plastic; few medium, fine, and coarse roots; 80 percent rock fragments 6 to 16 inches in length; very strongly calcareous, lime segregated on bottom of larger rock fragments; moderately alkaline (pH 8.2); abrupt, smooth boundary.

R—16 inches, fractured limestone bedrock.

Depth to limestone bedrock is 10 to 20 inches. The soil is very flaggy heavy loam or clay loam. Content of rock fragments is 50 to 80 percent.

The A horizon is 3 to 4 inches thick. It is brown, dark brown or very dark grayish brown to dark grayish brown when dry and very dark brown to dark brown or very dark grayish brown when moist. Reaction is neutral to mildly alkaline.

The Cca horizon is brown or dark grayish brown to grayish brown when dry and very dark brown to dark brown or very dark grayish brown when moist. Reaction is mildly alkaline to moderately alkaline.

LUE—Lundy channery silt loam, 5 to 40 percent slopes. This soil is on ridges and mountainsides. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Mower clay loam, 5 to 30 percent slopes; Rock outcrop; and Lizzant stony loam, 4 to 20 percent slopes.

This soil is used as summer range by sheep, cattle, and deer. A few areas have been chained and seeded successfully. Capability unit VI-S nonirrigated; Mountain Shallow Loam range site.

Manassa Series

The Manassa series consists of well-drained soils that formed in alluvium derived from shale, sandstone, and limestone on alluvial fans, alluvial plains, and lake terraces. Manassa soils are commonly associated with Genola, Harding, Mellor, and Woodrow soils. Slope is 1 to 5 percent.

Elevation ranges from 5,100 to 6,000 feet. The average annual precipitation ranges from 8 to 12 inches, and the mean annual air temperature ranges from 45° to 49° F. The frost-free period is 115 to 130 days. Vegetation is greasewood, shadscale, squirrel-tail, bur buttercup, and pickleweed.

In a representative profile the surface layer is pale-brown silt loam and loam about 6 inches thick. The substratum to a depth of 60 inches is very pale brown, light-brown, and pink stratified silt loam, silty clay loam, loam, and fine sandy loam.

The Manassa soils are strongly calcareous, moderately saline to strongly saline, and moderately alkaline to very strongly alkaline. Permeability is slow. The available water capacity is 2 to 3 inches. The high salt content reduces the amount of water available to plants. The water-supplying capacity is less than 4 inches annually. The effective root zone is about 60 inches.

Manassa soils are used as range. They are also used as habitat by upland game birds and rabbits.

Representative profile of Manassa silt loam, 1 to 5 percent slopes, in a range area of Manassa-Mellor complex 4 miles north of Fayette, about 3,334 feet east, 2,300 feet south of the northwest corner of sec. 35, T. 17 S., R. 1 W., Sanpete County:

A11—0 to 2 inches, pale-brown (10YR 6/3) loam, dark brown (10YR 4/3) when moist; weak, fine, granular structure; soft, friable, slightly sticky and slightly plastic; many very fine roots; few very fine pores; strongly calcareous; moderately alkaline (pH 8.2); abrupt, smooth boundary.

A12—2 to 6 inches, pale-brown (10YR 6/3) silt loam, dark brown (10YR 4/3) when moist; weak, thin, platy structure; soft, firm, sticky and plastic; common very fine, few fine, and few medium roots; few very fine and fine pores; strongly calcareous; strongly alkaline (pH 8.6); clear, smooth boundary.

C1—6 to 12 inches, very pale brown (10YR 7/3) silt loam, brown (10YR 5/3) when moist; weak, fine, granular structure; slightly hard, firm, sticky and plastic; common fine and few medium roots; few very fine and fine pores; strongly calcareous; strongly alkaline (pH 8.8); clear, smooth boundary.

C2—12 to 25 inches, pink (7.5YR 7/3) heavy silty clay loam, brown (7.5YR 5/3) when moist; moderate, medium, subangular blocky structure; hard, very firm, sticky and plastic; few very fine and fine roots; few very fine and fine pores; strongly calcareous; very strongly alkaline (pH 9.2); clear, smooth boundary.

C3—25 to 33 inches, pink (7.5YR 7/3) silty clay loam, brown (7.5YR 5/3) when moist; weak, medium, subangular blocky structure; very hard, firm, sticky and plastic; few very fine roots; common very fine, few fine and medium pores; strongly calcareous; very strongly alkaline (pH 9.2); clear, wavy boundary.

C4—33 to 54 inches, light-brown (7.5YR 6/3) loam, brown

(7.5YR 5/3) when moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine and fine roots; few very fine pores; strongly calcareous; very strongly alkaline (pH 9.2); gradual, smooth boundary.

C5—54 to 60 inches, light-brown (7.5YR 6/3) heavy fine sandy loam, brown (7.5YR 5/3) when moist; massive; soft, friable, slightly sticky and slightly plastic; few very fine roots; few very fine pores; strongly calcareous; very strongly alkaline (pH 9.2).

Texture between depths of 10 and 40 inches is dominantly silty clay loam, but thin lenses of silt loam, clay loam, or loam are common.

The A horizon is 6 to 9 inches thick. It is pale brown or light brown to pinkish gray or pale brown when dry and dark brown to grayish brown when moist. Reaction is moderately alkaline to strongly alkaline.

The C horizon is pink, very pale brown, or light brown to pinkish gray when dry and brown or dark brown to light yellowish brown when moist. Reaction is strongly alkaline to very strongly alkaline. Below a depth of 40 inches the C horizon ranges from fine sandy loam to silty clay.

MA—Manassa-Mellor complex. This mapping unit is on alluvial plains, lake terraces, and alluvial fans. It is about 40 percent Manassa silt loam, 1 to 5 percent slopes; 35 percent Mellor silt loam; 15 percent strongly saline-alkali very fine sandy loam on the steepest side slopes or terraces above the Sevier River; and small areas of Harding silt loam and wet, saline soils. The Manassa and Mellor soils are in the gently sloping areas.

Runoff is medium on the Manassa soil, and the hazard of erosion is moderate. Runoff is rapid on the Mellor soil, and the hazard of erosion is severe.

This mapping unit is used as range and as habitat by upland game birds and rabbits. Capability unit VII-S8 nonirrigated; Semi-desert Alkali Flats range site.

Manila Series

The Manila series consists of well-drained soils that formed in alluvium derived from limestone, sandstone, and quartzite on alluvial fans. Manila soils are commonly associated with Ant Flat, Clegg, Deer Creek, and Toehead soils. Slope is 3 to 10 percent.

Elevation ranges from 6,000 to 7,000 feet. The average annual precipitation ranges from 16 to 18 inches, and the mean annual air temperature is about 45° F. The frost-free period is 80 to 100 days. Vegetation is oakbrush, big sagebrush, and perennial grasses.

In a representative profile the surface layer is brown loam and silt loam about 17 inches thick. The subsoil to a depth of 60 inches is light-brown silty clay loam, silty clay, and clay.

Reaction is slightly acid to neutral. Permeability is slow. The available water capacity is 8 to 12 inches. The water-supplying capacity of nonirrigated soils is 11 to 14 inches annually. The effective root zone is about 60 inches.

Manila soils are used for nonirrigated alfalfa, small grain, and grass. They are also used as range.

Representative profile of Manila loam, 3 to 10 percent slopes, in a range site about 3 miles northwest of the Milburn church, 250 feet east and 247 feet south of the northwest corner of sec. 25, T. 12 S., R. 4 E., Sanpete County:

A11—0 to 4 inches, brown (10YR 4/3) loam, very dark grayish brown (10YR 3/2) when moist; weak, thin, platy structure; slightly hard, friable, slightly sticky and plastic; many fine and very fine roots; few fine pores; slightly acid (pH 6.2); clear, smooth boundary.

A12—4 to 11 inches, brown (10YR 4/3) loam, very dark grayish brown (10YR 3/2) when moist; weak, thick, platy structure; slightly hard, friable, slightly sticky and plastic; common very fine roots; few medium pores; slightly acid (pH 6.3); clear, wavy boundary.

A3—11 to 17 inches, brown (10YR 5/3) heavy silt loam, dark brown (10YR 3/3) when moist; moderate, medium, subangular blocky structure; hard, firm, slightly sticky and plastic; few very fine roots; common medium and few very fine pores; slightly acid (pH 6.2); gradual, smooth boundary.

B1—17 to 28 inches, light-brown (7.5YR 6/4) silty clay loam, brown (7.5YR 4/2) when moist; strong, fine, angular blocky structure; very hard, firm, sticky and plastic; few fine and very fine roots; few medium and fine pores; many krotovinas; slightly acid (pH 6.3); gradual, smooth boundary.

B21t—28 to 45 inches, light-brown (7.5YR 6/4) silty clay, brown (7.5YR 4/4) when moist; weak, medium, prismatic structure parting to strong, medium, angular blocky; extremely hard, very firm, sticky and plastic; few very fine roots; few fine pores; many moderately thick clay films on peds and in pores; neutral (pH 6.6); gradual, smooth boundary.

B22t—45 to 60 inches, light-brown (7.5YR 6/4) clay, brown (7.5YR 4/4) when moist; medium, strong, angular blocky structure; extremely hard, very firm, very sticky and very plastic; few very fine roots; few very fine pores; many moderately thick clay films on peds and in pores; slightly acid (pH 6.1).

The A1 horizon is 11 to 17 inches thick. It is brown, dark grayish brown, or grayish brown when dry and very dark grayish brown or dark brown when moist. The A1 horizon ranges from loam to silt loam.

The B2t horizon is 30 to 50 inches thick. It is light brown to pinkish gray when dry and brown or dark brown when moist. The B2t horizon is silty clay or clay. Content of gravel and cobbles ranges from 0 to 50 percent below a depth of 40 inches.

MbC—Manila loam, 3 to 10 percent slopes. This soil is on alluvial fans. Runoff is medium, and the hazard of erosion is moderate. In places the surface layer has 20 to 30 percent gravel and the soil below a depth of about 40 inches is 20 to 50 percent gravel and cobbles, especially west of Log Hollow northwest of Fountain Green.

Included with this soil in mapping are small areas of Ant Flat loam, low rainfall, 4 to 8 percent slopes; Clegg loam, 3 to 10 percent slopes; and Toehead silt loam, 2 to 4 percent slopes.

This soil is used mainly for nonirrigated alfalfa, small grain, and grass. It is also used as range. Capability unit IIIe-M nonirrigated; Mountain Loam (Oak) range site.

Mayfield Series

The Mayfield series consists of well-drained soils that formed in alluvium derived from shale on alluvial fans. Mayfield soils are commonly associated with Badland, Billings, Ravola, and Sanpete soils. Slopes are usually smooth and are 2 to 5 percent.

Elevation ranges from 5,000 to 6,000 feet. The average annual precipitation ranges from 8 to 12 inches, and the mean annual air temperature ranges from 45° to 49° F. The frost-free period is 115 to 130 days.

Vegetation is dominantly big sagebrush, shadscale, rabbitbrush, and annual weeds and grasses.

In a representative profile the surface layer is light-gray shaly loam about 5 inches thick. The substratum to a depth of 65 inches is 17 inches of light-gray loam and shaly loam; 8 inches of pale-yellow loam; and 35 inches of very pale brown shaly loam, silt loam, and shaly sandy loam.

The Mayfield soils are very strongly calcareous, and reaction is moderately alkaline to very strongly alkaline. Permeability is moderately rapid. The available water capacity is 5 to 8 inches. The water-supplying capacity of nonirrigated soils is 5 to 7 inches annually. The effective root zone is about 60 inches.

Mayfield soils are used as range.

Representative profile of Mayfield shaly loam, 2 to 5 percent slopes, eroded, in a range area, 1¼ miles west of Mayfield, 250 feet west of the road, about 1,320 feet west and 1,400 feet south of the northeast corner of sec. 30, T. 19 S., R. 2 E., Sanpete County:

A11—0 to 2 inches, light brownish-gray (2.5Y 6/2) shaly loam, grayish brown (2.5Y 5/2) when moist; moderate, thin, platy structure; slightly hard, friable, slightly sticky and slightly plastic; few fine and very fine roots; many fine and very fine vesicular pores; 20 percent shaly fragments, partly a surface mantle; very strongly calcareous; strongly alkaline (pH 9.0); abrupt, smooth boundary.

A12—2 to 5 inches, light-gray (2.5Y 7/2) shaly loam, grayish brown (2.5Y 5/3) when moist; moderate, thin, platy structure; hard, friable, slightly sticky and plastic; common fine roots and few very fine roots; common fine and very fine pores; 20 percent shaly fragments; very strongly calcareous; strongly alkaline (pH 9.0); clear, smooth boundary.

C1—5 to 11 inches, light-gray (2.5Y 7/2) loam, pale brown (10YR 6/3) when moist; weak, thick, platy structure; hard, friable, sticky and slightly plastic; few medium and fine roots; common very fine pores; 15 percent shale fragments; very strongly calcareous; strongly alkaline (pH 8.8); clear, wavy boundary.

C2—11 to 22 inches, light-gray (2.5Y 7/2) shaly loam, light yellowish brown (2.5Y 6/4) when moist; massive; slightly hard, friable, slightly sticky and plastic; few medium and fine roots; many fine and very fine pores; 25 percent shale fragments; very strongly calcareous; strongly alkaline (pH 8.6); clear, wavy boundary.

C3—22 to 30 inches, pale-yellow (2.5Y 7/3) loam, light yellowish brown (2.5Y 6/3) when moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; common very fine pores; 5 percent shale fragments; common gypsum flakes; very strongly calcareous, lime in flakes; strongly alkaline (pH 8.6); clear, smooth boundary.

C4—30 to 45 inches, very pale brown (10YR 7/3) shaly loam, pale brown (10YR 6/3) when moist; massive; hard, friable, sticky and plastic; few very fine roots; few fine and very fine pores; 25 percent shale fragments; few gypsum flakes; very strongly calcareous, lime in fine flakes; strongly alkaline (pH 8.8); clear, smooth boundary.

C5—45 to 56 inches, very pale brown (10YR 7/3) silt loam, pale brown (10YR 6/3) when moist; massive; slightly hard, friable, slightly sticky and plastic; few fine roots; few fine and medium pores; 6 to 10 percent shale fragments; common to few gypsum flakes; very strongly calcareous, lime in veins; strongly alkaline (pH 8.6); clear, wavy boundary.

C6—56 to 65 inches, very pale brown (10YR 7/3) shaly sandy loam, pale brown (10YR 6/3) when moist; massive; slightly hard, loose, nonsticky and slightly plastic; common fine pores; 25 percent shale fragments; very strongly calcareous, lime segregated on shale fragments; strongly alkaline (pH 8.6).

Between depths of 10 and 40 inches the soil ranges from loam, gravelly loam, or shaly loam to silty clay loam, gravelly silty clay loam, or shaly silty clay loam. Rock fragment content, dominantly shale, ranges from few to 35 percent but averages more than 20 percent.

The A1 horizon is 3 to 9 inches thick. It is light brownish gray or grayish brown to light gray or very pale brown when dry and grayish brown to brown or dark grayish brown when moist. Reaction is moderately alkaline to strongly alkaline.

The C horizon is light gray, light brownish gray, pale yellow, or very pale brown when dry and pale brown, light yellowish brown, or dark grayish brown to light brownish gray when moist. Reaction is moderately alkaline to very strongly alkaline. Gypsum flakes are few to common below a depth of about 10 inches.

McB—Mayfield shaly loam, 2 to 5 percent slopes. This soil is on alluvial fans. It has a profile similar to the one described as representative of the series, but it is not eroded. Runoff is medium, and the hazard of erosion is moderate. This soil is not gullied but slight sheet and rill erosion occur.

Included with this soil in mapping are small areas of Billings silty clay loam; Ravola loam, 2 to 5 percent slopes, eroded; and Ravola loam, 2 to 5 percent slopes.

This soil is used as range. Capability unit VIIe-S nonirrigated; Semi-desert Loam range site.

McB2—Mayfield shaly loam, 2 to 5 percent slopes, eroded. This soil is on alluvial fans. It has the profile described as representative of the series. Runoff is medium, and the hazard of erosion is moderate. This soil is moderately eroded. Sheet and rill erosion are common, and deep gullies occur about 300 to 600 feet apart.

Included with this soil in mapping are small areas of Ravola loam, 2 to 5 percent slopes; Ravola loam, 2 to 5 percent slopes, eroded; and Billings silty clay loam.

This soil is used as range and is a fair source of road fill. Capability unit VIIe-S nonirrigated; Semi-desert Loam range site.

Mellor Series

The Mellor series consists of well-drained soils that formed in alluvium derived from sandstone, shale, limestone, and lacustrine sediments on alluvial fans, flood plains, and lake terraces. Mellor soils are commonly associated with Harding and Manassa soils. Slope is 1 to 5 percent.

Elevation ranges from 5,100 to 6,000 feet. The average annual precipitation ranges from 8 to 12 inches, and the mean annual air temperature ranges from 46° to 49° F. The frost-free period is 115 to 130 days. Vegetation is dominantly greasewood, shadscale, and annual weeds and grasses.

In a representative profile the surface layer is pale-brown silt loam about 7 inches thick. The subsoil is light-brown and pink silty clay loam about 15 inches thick. The substratum to a depth of 60 inches is pink finely stratified silt loam, silty clay loam, and silty clay.

Reaction is strongly alkaline to very strongly alkaline, and the soils are moderately saline to strongly saline. Permeability is slow. The effective root zone is 60 inches or more.

Mellor soils are used as range.

Representative profile of Mellor silt loam, in a range area, 6 miles north of Fayette, about 2,470 feet north and 1,600 feet west of the southeast corner of sec. 27, T. 17 S., R. 1 W., Sanpete County:

A21—0 to 2 inches, pale-brown (10YR 6/3) silt loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, platy structure; soft, friable, slightly sticky and slightly plastic; common very fine roots; many, very fine, vesicular pores; moderately calcareous; moderately saline; strongly alkaline (pH 8.6); abrupt, smooth boundary.

A22—2 to 5 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 4/3) when moist; weak, thin, platy structure; soft, friable, slightly sticky and slightly plastic; common very fine roots and few fine roots; common very fine pores; moderately calcareous; moderately saline; strongly alkaline (pH 8.8); abrupt, smooth boundary.

A3—5 to 7 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 4/3) when moist; weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky and plastic; common very fine and few fine roots; common very fine and few fine pores; moderately calcareous; moderately saline; strongly alkaline (pH 8.6); abrupt, smooth boundary.

B21t—7 to 12 inches, light-brown (7.5YR 6/3) silty clay loam, brown (7.5YR 5/4) when moist; moderate, coarse, prismatic structure parting to strong, medium, angular blocky; hard, firm, sticky and very plastic; few fine and very fine roots; common very fine and few fine pores; common, moderately thick clay films on faces of peds; moderately calcareous, lime in fine soft rounded masses; very strongly alkaline (pH 9.6); clear, smooth boundary.

B22t—12 to 16 inches, light-brown (7.5YR 6/3) silty clay loam, brown (7.5YR 5/4) when moist; strong, medium, angular blocky structure; very hard, firm, sticky and plastic; few fine and very fine roots; common very fine and fine pores; common, moderately thick clay films; strongly calcareous, lime in fine soft rounded masses; very strongly alkaline (pH 9.6); clear, smooth boundary.

B3ca—16 to 22 inches, pink (7.5YR 7/3) silty clay loam, light brown (7.5YR 6/3) when moist; moderate, fine, angular blocky structure; very hard, firm, sticky and plastic; few very fine and fine roots; few very fine pores; very strongly calcareous; lime in veins and fine soft rounded masses; very strongly alkaline (pH 9.6); clear, smooth boundary.

C1ca—22 to 28 inches, pink (7.5YR 7/3) silty clay, light brown (7.5YR 6/4) when moist; moderate, medium, subangular blocky structure; very hard, very firm, sticky and very plastic; few very fine roots; few very fine pores; very strongly calcareous, lime in veins and soft rounded masses; very strongly alkaline (pH 9.6); clear, smooth boundary.

C2ca—28 to 40 inches, pink (7.5YR 7/3) silty clay loam, light brown (7.5YR 6/4) when moist; common, medium, distinct, dark yellowish-brown (10YR 4/4) fossil mottles; weak, medium, platy structure; very hard, firm, sticky and plastic; few very fine roots; few very fine pores; very strongly calcareous, lime in veins and fine soft rounded masses; very strongly alkaline (pH 9.6); clear, wavy boundary.

C3—40 to 60 inches, pink (10YR 7/3) silt loam, brown (10YR 5/3) when moist; massive; slightly hard, friable, slightly sticky and plastic; few very fine roots; few very fine pores; strongly calcareous; very strongly alkaline (pH 9.6).

The A2 horizon is 4 to 6 inches thick. It is pale brown or light brown to pink or very pale brown when dry and brown, dark grayish brown, or dark brown to grayish brown when moist. The A2 horizon is generally slightly calcareous or moderately calcareous but ranges to non-calcareous, and is nonsaline to moderately saline. Reaction is moderately alkaline to strongly alkaline.

The B2t horizon is light brown, reddish brown, light reddish brown, or brown, pale brown, or very pale brown

when dry and brown, reddish brown, or light brown to pale brown when moist. It is 7 to 13 inches thick. The B2t horizon is slightly calcareous to strongly calcareous and moderately saline to strongly saline. Texture of the B2t horizon is clay loam or silty clay loam.

The Cca horizon has colors similar to those of the B2t horizon. It is strongly calcareous or very strongly calcareous and strongly saline to very strongly saline. Reaction is moderately alkaline to very strongly alkaline. The Cca horizon ranges from fine sandy loam to silty clay.

Md—Mellor silt loam. This soil is on alluvial fans, flood plains, and lake terraces. Slope is 1 to 5 percent. This soil has the profile described as representative of the series. Runoff is rapid, and the hazard of erosion is severe. There is moderate sheet and rill erosion and in most places there are gullies 100 to 500 feet apart. The available water capacity is 1 to 2 inches. The high content of salt drastically reduces the amount of water available to plants. The water-supplying capacity is less than 4 inches annually.

Included with this soil in mapping are small areas of Harding silt loam; Manassa silty clay loam; and a very fine sandy loam. Also included is a similar soil with red color.

This soil is used as spring and late fall range by sheep and cattle. It is also used as habitat by upland game birds and small game. Capability unit VII_s-S8 nonirrigated; Semi-desert Alkali Flats range site.

Me—Mellor silt loam, leached surface. This soil is on flood plains. Slope is 1 to 5 percent. This soil has a profile similar to the one described as representative of the series, but the upper 12 inches is noncalcareous and nonsaline. Runoff is medium, and the hazard of erosion is severe. There is moderate sheet and rill erosion. Vegetation is big sagebrush, rabbitbrush, saltgrass, and greasewood. The available water capacity is 4½ to 6 inches. The salt content reduces the amount of water available to plants. The water-supplying capacity is 6 to 8 inches annually.

Included with this soil in mapping are small areas of Mellor silt loam and Keigley silt loam, 2 to 4 percent slopes.

This soil is used as range. A few fields have been seeded successfully to crested wheatgrass after the brush has been removed. Capability unit VI_e-S nonirrigated; Semi-desert Loam range site.

Moroni Series

The Moroni series consists of well-drained soils that formed in alluvium and colluvium derived from shale and mixed igneous and quartzite rocks on alluvial fans. Moroni soils are commonly associated with Atepic, Freedom, and Keigley soils. Slope is 2 to 8 percent.

Elevation ranges from 5,500 to 6,800 feet. The average annual precipitation ranges from 10 to 14 inches, and the mean annual air temperature ranges from 45° to 47° F. The frost-free period is 100 to 120 days. Vegetation is rabbitbrush, forbs, and annual weeds and grasses.

In a representative profile the surface layer is light brownish-gray silty clay about 9 inches thick. The substratum to a depth of 62 inches is light brownish-gray and light-gray silty clay and clay.

Moroni soils are moderately calcareous to strongly calcareous, and reaction is mildly alkaline to strongly

alkaline. Permeability is slow. The available water capacity is 8 to 12 inches. The water-supplying capacity is 8 to 11 inches annually. The effective root zone is about 60 inches.

Moroni soils are used mainly for nonirrigated and irrigated alfalfa, small grain, and grass. They are also used as range.

Representative profile of Moroni silty clay, 2 to 8 percent slopes, in an area seeded to crested wheatgrass, about 4 miles northwest of Mount Pleasant, 1,980 feet east and 165 feet south of the northwest corner of sec. 21, T. 14 S., R. 4 E., Sanpete County:

A11—0 to 2 inches, light brownish-gray (2.5Y 6/2) silty clay, grayish brown (2.5Y 5/2) when moist; moderate, fine, granular structure; very hard, firm, sticky and plastic; few very fine roots; few fine and very fine pores; moderately calcareous; moderately alkaline (pH 8.2); abrupt, smooth boundary.

A12—2 to 9 inches, light brownish-gray (2.5Y 6/2) silty clay, grayish brown (2.5Y 5/2) when moist; weak, medium, subangular blocky structure; very hard, firm, sticky and plastic; common very fine roots; few fine and very fine pores; moderately calcareous; moderately alkaline (pH 8.2); clear, smooth boundary.

C1—9 to 20 inches, light brownish-gray (2.5Y 6/2) silty clay, grayish brown (2.5Y 5/2) when moist; moderate, coarse, prismatic structure; extremely hard, very firm, sticky and plastic; few very fine roots; few very fine pores; cracks 1 to 2 centimeters in width and wedge-shaped peds at 15° angle, few slickensides; strongly calcareous, lime in fine veins; strongly alkaline (pH 8.6); gradual, smooth boundary.

C2—20 to 41 inches, light brownish-gray (2.5Y 6/2) silty clay, grayish brown (2.5Y 5/2) when moist; moderate, coarse, prismatic structure; extremely hard, very firm, sticky and plastic; few very fine roots; cracks 1 to 2 centimeters in width, wedge-shaped peds at 15° angle, common slickensides; strongly calcareous, lime in fine veins; strongly alkaline (pH 8.6); gradual, smooth boundary.

C3—41 to 62 inches, light-gray (2.5Y 7/2) clay, light brownish gray (2.5Y 6/2) moist; massive; extremely hard, very firm, very sticky and very plastic; strongly calcareous, lime in fine rounded masses and veins; strongly alkaline (pH 8.6).

The soils have cracks ½ inch to 3 inches in width to a depth of 20 inches. Slickensides are few to common at depths between 10 and 40 inches. Texture between depths of 10 and 40 inches is clay or silty clay.

The A horizon is 6 to 14 inches thick. It is light brownish gray, grayish brown, or pale brown when dry and grayish brown to dark grayish brown or brown when moist. The A horizon ranges from silty clay loam to silty clay. The C horizon is light brownish gray to pale brown or light gray when dry and grayish brown, dark grayish brown, or brown when moist.

MfC—Moroni silty clay, 2 to 8 percent slopes. This soil is on alluvial fans and colluvial side slopes. It has the profile described as representative of the series. Runoff is rapid, and the hazard of erosion is moderate to severe. Sheet and rill erosion are active in places, and some deep gullies are evident.

Included with this soil in mapping are small areas of Wales loam, 2 to 8 percent slopes, and Keigley silty loam, 2 to 4 percent slopes.

This soil is used mainly for nonirrigated alfalfa, small grain, and grass and irrigated alfalfa. It is also used as range. Capability units III_e-25 irrigated, IV_e-U2 nonirrigated; Upland Clay range site.

MGD—Moroni-Atepic complex, 2 to 30 percent slopes. This mapping unit is on foothills. It is about 55 percent Moroni silty clay, 2 to 8 percent slopes, in swales,

depressions, and less sloping areas; 25 percent Atepic shaly clay loam, 10 to 30 percent slopes, eroded, on ridges and steeper slopes; about 15 percent Wales loam, 2 to 8 percent slopes, in swales and depressions; and small areas of Keigley silt loam, 2 to 4 percent slopes, and Freedom silt loam, 2 to 10 percent slopes.

Runoff is rapid, and the hazard of erosion is severe. Sheet and rill erosion are active in places, and there are some deep gullies.

This mapping unit is used mainly for nonirrigated grass. It is also used as range. Capability unit IVE-UZ nonirrigated; Moroni soils in Upland Clay range site; Atepic soils in Upland Shallow Shale (Juniper-Pinon) range site.

Mortenson Series

The Mortenson series consists of well-drained soils that formed in colluvium and material derived from sandstone on mountainsides. Mortenson soils are commonly associated with Gothic and Skylick soils. Slope is 40 to 70 percent.

Elevation ranges from 6,700 to 9,700 feet. The average annual precipitation ranges from 25 to 35 inches, and the mean annual air temperature ranges from 43° to 45° F. The frost-free period is 70 to 80 days. Vegetation is Douglas-fir, concolor fir, scattered aspen, ninebark, and snowberry.

In a representative profile the surface layer is light brownish-gray and pale-brown silt loam and very pale brown very stony silt loam about 34 inches thick. The subsoil to a depth of about 60 inches is pale-brown very stony clay.

Reaction is medium acid to neutral. Permeability is slow. The available water capacity is 5 to 8 inches. The water-supplying capacity is 14 to 20 inches or more annually. The effective root zone is about 60 inches.

Mortenson soils are used for woodland and as habitat by wildlife.

Representative profile of Mortenson silt loam, 40 to 70 percent slopes, in a wooded area, 2,200 feet north and 400 feet west of the southeast corner of sec. 15, T. 15 S., R. 5 E., Sanpete County:

A21—0 to 4 inches, light brownish-gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) when moist; moderate, thin, platy structure; soft, friable, nonsticky and slightly plastic; few fine and common medium roots; few very fine and fine pores; slightly acid (pH 6.1); clear, smooth boundary.

A22—4 to 12 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 4/3) when moist; massive; soft, friable, slightly sticky and slightly plastic; few fine and common medium roots; common very fine pores; few charcoal bits; 10 percent cobbles; slightly acid (pH 6.1); gradual, smooth boundary.

A23—12 to 28 inches, very pale brown (10YR 7/3) very stony silt loam, brown (10YR 5/3) when moist; slightly hard, friable, nonsticky and slightly plastic; few very fine, common medium, and few coarse roots; common very fine pores; 45 percent cobbles and stones and 15 percent gravel; medium acid (pH 6.0); gradual, wavy boundary.

A&B—28 to 34 inches, material that is 60 percent A2 horizon and 40 percent B2t horizon; A2 part is very pale brown (10YR 7/3) very stony silt loam, brown (10YR 5/3) when moist; massive; slightly hard, friable, nonsticky and slightly plastic; few medium and few fine roots; common very fine pores; slightly acid (pH

6.1); B2t part is as described in the B21t horizon; gradual, wavy boundary.

B21t—34 to 42 inches, pale-brown (10YR 6/3) very stony clay, yellowish brown (10YR 5/4) when moist; strong, medium, angular blocky structure; very hard, very firm, very sticky and very plastic; few fine and medium roots; common very fine pores; many moderately thick clay films; 45 percent cobbles and stones, 15 percent gravel; slightly acid (pH 6.1); clear, smooth boundary.

B22t—42 to 49 inches, pale-brown (10YR 6/3) very stony clay, light yellowish brown (10YR 6/4) when moist; strong, medium, angular blocky structure; very hard, very firm, very sticky and very plastic; few medium and fine roots; common very fine pores; common moderately thick clay films; 40 percent cobbles and stones, 15 percent gravel; slightly acid (pH 6.1); gradual, smooth boundary.

B23t—49 to 60 inches, pale-brown (10YR 6/3) very stony clay, pale brown (10YR 6/3) when moist; strong, medium, angular blocky structure; very hard, very firm, very sticky and very plastic; few very fine roots; few fine and common very fine pores; many thin clay films; 50 percent cobbles and stones, 10 percent gravel; slightly acid (pH 6.1).

The content of cobbles and stones ranges from 35 to 70 percent.

The A1 horizon is less than 6 inches thick in places. The A2 horizon is 24 to 40 inches thick. It is light brownish gray, pale brown, very pale brown, light brown, or pinkish gray to light gray when dry and brown, dark grayish brown, dark brown, or grayish brown to light gray or very pale brown when moist. The A2 horizon ranges from silt loam to cobbly or very cobbly silt loam and stony or very stony silt loam. Content of rock fragments ranges from few to 50 percent.

The B2t horizon is pale brown, brown, grayish brown, and very pale brown when dry and yellowish brown or light yellowish brown, dark brown, brown, or pale brown to dark yellowish brown when moist. The B2t horizon ranges from very cobbly or very stony silty clay to very cobbly or very stony clay.

MHG—Mortenson silt loam, 40 to 70 percent slopes.

This soil is on northern mountainsides. It has the profile described as representative of the series. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Mortenson fine sandy loam, thin solum variant, 8 to 30 percent slopes; Skylick silt loam, 30 to 70 percent slopes; and a similar soil that has a surface layer less than 24 inches thick.

This soil is used mainly for woodland of Douglas-fir, concolor fir, spruce, and aspen. It is also used as summer habitat by deer and elk.

This soil has a site index of about 76 for alpine fir and about 51 for Engelmann spruce. The average annual production is about 170 board feet of sawtimber per acre for the alpine fir and 190 board feet for Engelmann spruce. Seedling mortality, windthrow hazard, and plant competition are slight; equipment restriction is moderate to severe. Capability unit VIIc-HC nonirrigated; range site not assigned.

MKG—Mortenson-Skylick association, very steep. This mapping unit is on mountainsides. It is about 50 percent Mortenson silt loam, 40 to 70 percent slopes, mainly on northern exposures; about 30 percent Skylick silt loam, 30 to 70 percent slopes, on all exposures; about 15 percent Pritchett silt loam, 20 to 40 percent slopes, on gentler slopes; and small areas of Rock outcrop and Gothic stony loam, 25 to 40 percent slopes, eroded.

Runoff is medium on both Mortenson and Skylick soils, and the hazard of erosion is moderate.

The Mortenson silt loam is used for timber production, and Douglas-fir, concolor fir, Engelmann spruce, and some aspens are grown. It is also used as summer habitat by deer and elk. The Skylick silt loam is used as summer range by sheep, cattle, deer, and elk. It is also used for the production of aspen.

This mapping unit has a site index of about 76 for alpine fir, about 51 for Engelmann spruce, and 67 for aspen. The average annual production is about 170 board feet of sawtimber per acre for alpine fir, 190 board feet per acre for Engelmann spruce, and about 20 cubic feet of cordwood or 52 feet of sawtimber for aspen. For alpine fir and Engelmann spruce, windthrow hazard and plant competition are slight; equipment restriction is slight. For aspen seedling mortality is moderate; windthrow hazard and plant competition are slight; and equipment restriction is moderate to severe. Mortenson soils in capability unit VII_s-HC nonirrigated, range site not assigned; Skylick soils in capability unit VII_e-H nonirrigated, High Mountain Loam (Aspen) range site.

Mortenson Variant

The Mortenson variant consists of well-drained soils that formed in colluvium and residuum derived from shale, sandstone, and limestone on mountainsides. Slope is 8 to 30 percent.

Elevation ranges from 7,500 to 9,000 feet. The average annual precipitation ranges from 25 to 35 inches, and the mean annual air temperature ranges from 43° to 45° F. The frost-free period is 70 to 80 days. Vegetation is mainly fir trees.

In a representative profile the surface layer is brown and very pale brown fine sandy loam and very fine sandy loam about 8 inches thick. The subsoil is brown, strong-brown, and light reddish-brown clay about 22 inches thick. The substratum is light-brown cobbly clay about 14 inches thick. Shale bedrock is at a depth of 44 inches.

Permeability is slow. The available water capacity is 7 to 8 inches. The water-supplying capacity is about 14 to 20 inches or more annually. Root penetration is restricted by the shale at a depth of 40 to 50 inches.

Mortenson variant is used for woodland and as habitat by wildlife.

Representative profile of Mortenson fine sandy loam, thin solum variant, 8 to 30 percent slopes, in a wooded area about 4 miles east of Spring City, 1,815 feet east and 1,980 feet north of the southwest corner of sec. 31, T. 15 S., R. 5 E., Sanpete County:

A21—0 to 4 inches, brown (10YR 4/3) fine sandy loam, dark brown (10YR 3/3) when moist; weak, thick, platy structure; soft, very friable, nonsticky and slightly plastic; few very fine, fine, and medium roots; few very fine pores; neutral (pH 6.6); abrupt, smooth boundary.

A22—4 to 8 inches, very pale brown (10YR 7/3) very fine sandy loam, dark grayish brown (10YR 4/2) when moist; weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine, fine, and medium roots; few fine pores; neutral (pH 6.6); clear, smooth boundary.

B21t—8 to 16 inches, brown (7.5YR 5/4) clay, reddish

brown (5YR 4/3) when moist; weak, coarse, prismatic structure parting to strong, coarse, angular blocky; extremely hard, extremely firm, very sticky and very plastic; few fine, medium, and coarse roots; continuous thin and common moderately thick clay films; neutral (pH 6.6); gradual, smooth boundary.

B22t—16 to 22 inches, strong-brown (7.5YR 5/5) clay, reddish brown (5YR 4/4) when moist; weak, medium, prismatic structure parting to strong, medium, angular blocky; extremely hard, extremely firm, very sticky and very plastic; few fine and medium roots; few fine pores; continuous thin and moderately thick clay films; 10 to 15 percent gravel, cobbles, and stones; slightly calcareous lime is in fine nodules; neutral (pH 6.8); gradual, smooth boundary.

B3ca—22 to 30 inches, light reddish-brown (5YR 6/3) clay, reddish brown (2.5YR 4/4) when moist; strong, medium, angular blocky structure; extremely hard, very firm, very sticky and very plastic; few very fine, fine, and medium roots; common moderately thick clay films; 10 to 15 percent stones, cobbles, and gravel; strongly calcareous, lime in veins; moderately alkaline (pH 8.0); gradual, wavy boundary.

Cca—30 to 44 inches, light-brown (7.5YR 6/4) cobbly clay, reddish brown (5YR 4/4) when moist; moderate, fine, angular blocky structure; extremely hard, very firm, very sticky and very plastic; few fine and medium roots; common thin clay films; 20 percent stones, cobbles, and gravel; strongly calcareous, lime in veins; moderately alkaline (pH 8.2); gradual, wavy boundary.

R—44 inches, weathered shale bedrock.

The A2 horizon is 6 to 10 inches thick. It is brown to very pale brown when dry and dark brown to dark grayish brown when moist.

The B2t horizon is 12 to 20 inches thick. It is brown to strong brown when dry and reddish brown to yellowish red when moist. It ranges from clay to silty clay and contains less than 20 percent cobbles and stones. The B2t horizon is neutral to mildly alkaline.

The Cca horizon is light brown to light reddish brown when dry and reddish brown when moist. It is clay or cobbly clay, and content of cobbles and stones is 15 to 25 percent. The Cca horizon is strongly calcareous, and reaction is moderately alkaline to strongly alkaline.

MLD—Mortenson fine sandy loam, thin solum variant, 8 to 30 percent slopes. This soil is on mountainsides. Runoff is medium, and the hazard of erosion is slight.

Included with this soil in mapping are small areas of Mortenson silt loam, 40 to 70 percent slopes, and Skylick silt loam, 4 to 30 percent slopes.

This soil is used mainly for woodland of Douglas-fir, concolor fir, spruce, and aspen. It is also used as summer habitat by deer and elk.

This soil has a site index of about 73 for concolor fir and about 82 for Douglas-fir. The average annual production is about 150 board feet per acre for concolor fir and 212 board feet per acre for Douglas-fir. Seedling mortality, windthrow hazard, plant competition, and equipment restrictions are slight. Capability unit VII_s-HC nonirrigated; range site not assigned.

Mountainville Series

The Mountainville series consists of well-drained soils that formed in alluvium derived from sandstone, limestone, and quartzite on alluvial fans (fig. 8). Mountainville soils are commonly associated with Borvant, Donnardo, Doyce, and Pavant soils. Slope is 2 to 10 percent.

Elevation ranges from 5,600 to 6,200 feet. The average annual precipitation ranges from 12 to 14 inches,



Figure 8.—View of the Manti Mountains from an area too stony for cultivation. The soil is Mountainville very stony loam, 2 to 8 percent slopes.

and the mean annual air temperature ranges from 45° to 47° F. The frost-free period is 110 to 120 days. Vegetation is big sagebrush, perennial grasses, and yellowbrush.

In a representative profile the surface layer is brown very stony sandy loam and fine sandy loam about 11 inches thick. The subsoil is brown stony loam and very stony sandy clay loam about 27 inches thick. The substratum to a depth of about 64 inches is very pale brown, strongly calcareous very stony loam.

Permeability is moderate. Available water capacity is 4 to 6 inches. The effective root zone is 60 inches or more.

Mountainville soils are used mainly as range or pasture.

Representative profile of Mountainville very stony sandy loam, 2 to 8 percent slopes, in a pasture area, about 3 miles northeast of Mount Pleasant, between North Creek and Mountainville, about 1,600 feet south and 2,800 feet east of the northwest corner of sec. 31, T. 14 S., R. 5 E., Sanpete County:

A11—0 to 4 inches, brown (10YR 5/3) very stony sandy loam, dark brown (10YR 3/3) when moist; weak, medium, platy structure; slightly hard, friable, nonsticky and slightly plastic; common very fine and few fine roots; few very fine pores; 10 to 25 percent of surface is covered by stones or cobbles; moderately calcareous; mildly alkaline (pH 7.8); abrupt, smooth boundary.

A12—4 to 11 inches, brown (10YR 5/3) very stony fine sandy loam, dark brown (10YR 3/3) when moist; weak, fine, granular structure; slightly hard, friable, nonsticky and slightly plastic; few fine and common very fine roots; few very fine and fine pores; 50 percent rock fragments, dominantly stones; moderately calcareous; moderately alkaline (pH 8.2); clear, smooth boundary.

B1—11 to 20 inches, brown (10YR 5/3) stony loam, dark brown (7.5YR 3/2) when moist; moderate, fine, granular structure; hard, friable, slightly sticky and plastic; common fine and few medium roots; few very fine, fine, and medium pores; 40 percent rock fragments; noncalcareous; mildly alkaline (pH 7.8); clear, smooth boundary.

B21t—20 to 31 inches, brown (7.5YR 5/4) very stony sandy clay loam, dark brown (7.5YR 4/4) when moist; moderate, medium, angular blocky structure; very hard, firm, sticky and plastic; few fine, very fine, and medium roots; common very fine and few fine pores; few thin clay films; 50 percent rock fragments; lime coatings on rock fragments; mildly alkaline (pH 7.8); gradual, smooth boundary.

B22t—31 to 38 inches, brown (7.5 YR 5/4) very stony sandy clay loam, dark brown (7.5YR 4/4) when moist; moderate, medium, angular blocky structure; very hard, firm, sticky and plastic; common fine, few very fine and medium roots; few fine and very fine pores; few moderately thick clay films; 70 percent rock fragments; lime coatings on rock fragments; mildly alkaline (pH 7.8); abrupt, wavy boundary.

C1ca—38 to 56 inches, very pale brown (10YR 8/3) very stony loam, pale brown (10YR 6/3) when moist; massive; hard, friable, slightly sticky and plastic; few fine

and very fine roots; common very fine and few fine pores; 60 percent rock fragments; strongly calcareous, lime coatings on rock fragments, in veins, and accumulated in soft rounded masses; strongly alkaline (pH 8.8); abrupt, wavy boundary.

C2—56 to 64 inches, very pale brown (10YR 7/3) very stony light loam, brown (10YR 5/3) when moist; massive; hard, friable, slightly sticky and slightly plastic; few very fine roots; few fine and very fine pores; 50 percent rock fragments; strongly calcareous, lime in veins; very strongly alkaline (pH 9.2).

The A horizon is 7 to 11 inches thick. It is brown, dark brown, or dark grayish brown to grayish brown when dry and dark brown, very dark brown, or very dark grayish brown when moist. The A horizon is noncalcareous to moderately calcareous, and reaction ranges from neutral to moderately alkaline.

The B2t horizon is 15 to 20 inches thick. It is brown, light brown, or pale brown to yellowish brown or light yellowish brown when dry and dark brown or brown to dark yellowish brown when moist. The B2t horizon ranges from stony or very stony sandy clay loam to stony or very stony clay loam. Content of cobbles and stones ranges from 35 to 80 percent. The B2t horizon is noncalcareous to moderately calcareous, and reaction ranges from neutral to moderately alkaline.

The Cca horizon is very pale brown or pink when dry and pale brown, brown, light brown, yellowish brown, or light yellowish brown when moist. It ranges from stony or very stony sandy clay loam to stony or very stony fine sandy loam. Content of stones and cobbles is 35 to 75 percent. The Cca horizon is strongly calcareous to very strongly calcareous, and reaction ranges from moderately alkaline to strongly alkaline.

MmC—Mountainville very stony sandy loam, 2 to 8 percent slopes. This soil is on alluvial fans. It has the profile described as representative of the series (fig. 9). Runoff is medium, and the hazard of erosion is moderate. About 10 to 25 percent of the surface is covered by stones or cobbles. The water-supplying capacity is 6 to 8 inches annually.

Included with this soil in mapping are small areas of Doyce loam, 4 to 8 percent slopes; Pavant loam, 4 to 8 percent slopes; small areas of Mountainville soils that have 10 to 25 percent of the surface covered by boulders; and small areas where only 1 to 10 percent of the surface is covered by stones.

This soil is used mainly as range or pasture. A few small areas are irrigated. It is a fair source of road fill. Capability unit VIIs-U nonirrigated; Upland Stony Loam range site.

MnC—Mountainville very stony loam, cool, 3 to 10 percent slopes. This soil is on alluvial fans. It has a mean annual temperature of 45° to 47° F., an average annual precipitation of 14 to 16 inches, and an elevation of 6,200 to 6,900 feet, which is higher than typical for the Mountainville series. The water-supplying capacity is 8 to 10 inches annually. Runoff is medium and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Watkins Ridge silt loam, 1 to 6 percent slopes, and Lizzant stony loam, 4 to 20 percent slopes.

This soil is used mainly as range or pasture. A few small areas are irrigated. It is a fair source of road fill. Capability unit VIIs-M nonirrigated; Mountain Stony Loam range site.

MoC—Mountainville-Doyce complex, 2 to 8 percent slopes. This mapping unit is on alluvial fans. It is about 50 percent Mountainville very stony sandy loam, 2 to 8 percent slopes, on ridges and the steeper side



Figure 9.—Mountainville very stony sandy loam, 2 to 8 percent slopes. Depth is marked in feet.

slopes; 30 percent Doyce loam, 2 to 4 percent slopes, in swales and less sloping areas; about 15 percent Pavant loam, 4 to 8 percent slopes, on side slopes; and small areas of Donnardo very stony loam, 4 to 16 percent slopes, and Borvant very stony loam, 2 to 10 percent slopes.

Runoff is medium on the Mountainville soils, and the hazard of erosion is moderate. Runoff is slow on the Doyce soils, and the hazard of erosion is moderate.

This mapping unit is used as range and pasture. In a few small areas the Doyce loam is cultivated and irrigated. Capability unit VII_s-U nonirrigated; Mountainville soil in Upland Stony Loam range site, Doyce soil in Upland Loam range site.

Mountainville Variant

The Mountainville variant consists of well-drained soils that have a hardpan 20 to 40 inches below the surface. This variant is formed in alluvium derived from mixed igneous, quartzite, and limestone rocks on alluvial fans. Slope is 4 to 20 percent.

Elevation ranges from 5,700 to 6,000 feet. The average annual precipitation ranges from 12 to 14 inches, and the mean annual air temperature ranges from 45° to 47° F. The frost-free period is 110 to 120 days. Vegetation is big sagebrush, perennial grasses, and annual weeds and grasses.

In a representative profile the surface layer is brown cobbly fine sandy loam and cobbly loam about 8 inches thick. The subsoil is yellowish-brown cobbly clay about 12 inches thick. The substratum is very pale brown very cobbly sandy clay loam about 3 inches thick over an indurated hardpan.

Permeability is slow above the hardpan. The available water capacity is 2 to 3 inches. The water-supplying capacity is about 6 inches annually. The effective root zone extends to the hardpan, or from 20 to 40 inches.

The Mountainville variant is used as range.

Representative profile of Mountainville cobbly fine sandy loam, hardpan variant, 4 to 20 percent slopes, in a range site 1 mile southeast of Fountain Green, about 2,310 feet west and 1,485 feet north of the south-east corner of sec. 8, T. 14 S., R. 3 E., Sanpete County:

A11—0 to 3 inches, brown (10YR 5/3) cobbly fine sandy loam, dark brown (10YR 3/3) when moist; moderate, thin, platy structure; soft, friable, nonsticky and nonplastic; few very fine roots; few fine pores; 20 percent cobbles and gravel, mainly a surface mantle; noncalcareous; mildly alkaline (pH 7.4); clear, smooth boundary.

A12—3 to 8 inches, brown (10YR 5/3) cobbly heavy loam, dark brown (10YR 5/3) when moist; weak, medium, subangular blocky structure; slightly hard, friable, sticky and slightly plastic; few fine and medium roots; few fine pores; 35 percent cobbles and 10 percent gravel; noncalcareous; mildly alkaline (pH 7.6); gradual, smooth boundary.

B2t—8 to 20 inches, yellowish-brown (10YR 5/4) cobbly clay, brown (7.5YR 4/4) when moist; weak, medium, prismatic structure parting to strong, medium, angular blocky; hard, firm, sticky and plastic; few fine and very fine roots; few fine pores; common moderately thick clay films on peds and gravel; 45 percent cobbles and 10 percent gravel; noncalcareous; mildly alkaline (pH 7.8); clear, smooth boundary.

C1ca—20 to 23 inches, very pale brown (10YR 8/3) very cobbly sandy clay loam, pale brown (10YR 6/3) when moist; massive; slightly hard, firm, slightly sticky and slightly plastic; few fine roots; 30 percent gravel and 20 percent cobbles; strongly calcareous, lime in soft rounded masses; strongly alkaline (pH 9.0); abrupt, smooth boundary.

C2cam—23 inches, indurated lime-cemented hardpan.

Depth to an indurated lime hardpan is 20 to 40 inches.

The A horizon is 8 to 11 inches thick. It is brown to grayish brown when dry and dark brown to very dark grayish brown when moist. The A horizon is noncalcareous

to moderately calcareous, and reaction is mildly alkaline to moderately alkaline.

The B2t horizon is 12 to 16 inches thick. It is yellowish brown to brown when dry and brown to dark brown when moist. It ranges from cobbly clay to cobbly heavy sandy clay loam and has 20 to 50 percent cobbles, gravel, and stones. The B2t horizon is noncalcareous to moderately calcareous, and reaction is mildly alkaline to moderately alkaline.

The Cca horizon is very pale brown to light gray when dry and pale brown to light brownish gray when moist. The Cca horizon ranges from very cobbly sandy clay loam to very cobbly loam and has 50 to 70 percent cobbles and gravel. It is moderately calcareous to strongly calcareous, and reaction is moderately alkaline to strongly alkaline.

MrD—Mountainville cobbly fine sandy loam, hardpan variant, 4 to 20 percent slopes. This soil is on alluvial fans. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Bagard very stony clay loam, 10 to 40 percent slopes, and Birdow very fine sandy loam, 2 to 4 percent slopes.

This soil is used as spring and fall range by sheep and cattle. Capability unit VI_s-U nonirrigated; Upland Stony Loam range site.

Mower Series

The Mower series consists of well-drained soils that are 20 to 40 inches deep over shale and sandstone bedrock. These soils formed in local alluvium, colluvium, and residuum derived from shale and sandstone on mountainsides and broad ridges. Mower soils are commonly associated with Clegg, Lizzant, Lundy, and Sedwell soils. Slope is 5 to 50 percent.

Elevation ranges from 6,500 to 8,000 feet. The average annual precipitation ranges from 14 to 20 inches, and the mean annual air temperature ranges from 43° to 45° F. The frost-free period is 90 to 110 days. Vegetation is big sagebrush, birchleaf mountain-mahogany, manzanita, and perennial grasses.

In a representative profile the surface layer is grayish-brown clay loam about 11 inches thick. The subsoil is light brownish-gray heavy silty clay loam about 6 inches thick. The substratum is white shaly silty clay loam about 18 inches thick. Shale bedrock is at a depth of 35 inches.

The Mower soils are very strongly calcareous. Permeability is moderate. The available water capacity is 4 to 5 inches. The water-supplying capacity is 6 to 10 inches annually. Root penetration is restricted by shale below a depth of about 30 inches.

Mower soils are used as range.

Representative profile of Mower clay loam, 5 to 30 percent slopes, in a range area near the head of Mellor Canyon, 1/4 mile south of the drift fence, about 1,200 feet east and 800 feet south of the northwest corner of sec. 34, T. 17 S., R. 1 E., Sanpete County:

A11—0 to 2 inches, grayish-brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, granular structure; slightly hard, firm, sticky and plastic; few fine roots; few fine pores; strongly calcareous; moderately alkaline (pH 8.2); clear, smooth boundary.

A12—2 to 11 inches, grayish-brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, subangular blocky structure parting to moderate, fine, granular; hard, firm, sticky and plastic; common fine roots; few fine pores; very

strongly calcareous; moderately alkaline (pH 8.2); clear, smooth boundary.

B2—11 to 17 inches, light brownish-gray (10YR 6/2) heavy silty clay loam, grayish brown (10YR 5/2) when moist; weak, medium, prismatic structure parting to moderate, medium, subangular blocky; very hard, firm, sticky and plastic; few fine and very fine roots; few fine pores; very strongly calcareous; strongly alkaline (pH 8.5); clear, smooth boundary.

C1ca—17 to 25 inches, white (10YR 8/2) shaly silty clay loam, pale brown (10YR 6/3) when moist; massive; very hard, firm, sticky and plastic; few fine and very fine roots; few very fine pores; 25 percent shale fragments, soft when moist, hard when dry; very strongly calcareous, lime in soft rounded masses; strongly alkaline (pH 8.6); abrupt, smooth boundary.

C2ca—25 to 35 inches, white (10YR 8/2) shaly silty clay loam, pale brown (10YR 6/2) when moist; moderate, medium, platy structure; few fine and very fine roots matted at top of horizon; no pores; 50 percent soft partly decomposed shale; very strongly calcareous; strongly alkaline (pH 8.7); abrupt, smooth boundary.

C3—35 inches, shale bedrock.

Depth to interbedded shale and sandstone bedrock ranges from 20 to 40 inches. Texture between a depth of 10 inches and bedrock ranges from shaly silt loam or loam to shaly silty clay loam or shaly clay loam.

The A horizon is 7 to 12 inches thick. It is grayish brown, dark brown, dark grayish brown, or brown when dry and very dark grayish brown or very dark brown to dark brown when moist. The A horizon is strongly calcareous to very strongly calcareous, and reaction is mildly alkaline to moderately alkaline.

The B2 horizon is 5 to 10 inches thick. It is light brownish gray, pale brown, very pale brown, yellowish brown, pinkish gray, pink, or light brown when dry and grayish brown, dark brown, brown, or dark grayish brown when moist. The B2 horizon is strongly calcareous to very strongly calcareous, and reaction is moderately alkaline to strongly alkaline.

The Cca horizon is white, pink, pinkish gray, or light brown to light brownish gray, light gray, pale brown, or very pale brown when dry and pale brown, dark brown, or brown to grayish brown, dark grayish brown, or light brownish gray when moist. The Cca horizon is very strongly calcareous, and reaction ranges from moderately alkaline to strongly alkaline.

MSD—Mower clay loam, 5 to 30 percent slopes. This soil is generally in fairly large areas on sagebrush-covered flats. It has the profile described as representative of the series. Runoff is medium, and the hazard of erosion is moderate. There are gullies and sheet and rill erosion in places.

Included with this soil in mapping are small areas of Mower stony clay loam, 5 to 30 percent slopes; Ant Flat stony loam, 8 to 25 percent slopes; and Atepic very cobbly silty clay loam, 8 to 40 percent slopes.

This soil is used as range by sheep, cattle, and deer. Grass has been successfully seeded in areas from which the sagebrush has been removed by chaining. Capability unit VIs-M nonirrigated; Mountain Stony Loam range site.

MTD—Mower stony clay loam, 5 to 30 percent slopes. This soil is generally in small areas on sagebrush-covered flats. It has a profile similar to the one described as representative of the series, but 2 to 10 percent of the surface is covered by stones and cobbles. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Mower clay loam, 5 to 30 percent slopes; Sedwell silt loam, 8 to 25 percent slopes; and Lundy channery silt loam, 5 to 40 percent slopes.

This soil is used as range by sheep, cattle, and deer. Grass has been successfully seeded in some areas from which the sagebrush has been removed by chaining. Capability unit VIs-M nonirrigated; Mountain Stony Loam range site.

MUF2—Mower very stony loam, 25 to 50 percent slopes, eroded. This soil is generally in small areas on southern and western exposures of mountainsides. It has a profile similar to the one described as representative of the series, but 10 to 25 percent of the surface is covered by stones or cobbles, and the surface layer is loam or silt loam. Runoff is medium, and the hazard of erosion is severe. Vegetation is mainly manzanita and scattered Rocky Mountain juniper and oakbrush.

Included with this soil in mapping are small areas of Mower stony clay loam, 5 to 30 percent slopes, and Deer Creek stony silt loam, high rainfall, 25 to 40 percent slopes.

This soil is used as range by sheep, cattle, deer, and elk. Capability unit VIIIs-M nonirrigated; Mountain Stony Loam range site.

MVE—Mower-Lundy complex, 5 to 40 percent slopes. This mapping unit is on sagebrush-covered flats, mountainsides, and broad ridges. It is about 50 percent Mower clay loam, 5 to 30 percent slopes, in swales, depressions, and less sloping areas; 35 percent Lundy channery silt loam, 5 to 40 percent slopes, on ridges and the steeper slopes; about 10 percent Clegg loam, 3 to 10 percent slopes; and small areas of Rock outcrop and Lizzant very cobbly loam, 20 to 40 percent slopes.

Runoff is medium, and the hazard of erosion is moderate. In places there are gullies and sheet and rill erosion.

The soils in this mapping unit are used as spring and fall range by sheep and cattle. Grass has been successfully seeded in some areas where the sagebrush was removed by chaining. Capability unit VIs-M nonirrigated; Mower soil in Mountain Stony Loam range site, Lundy soil in Mountain Shallow Loam range site.

Obrast Series

The Obrast series consists of well-drained soils that formed in alluvium and residuum derived from shale, limestone, and basic igneous rocks on mountainsides and alluvial fans. Obrast soils are commonly associated with Ant Flat, Deer Creek, Mower, and Harkers soils. Slope is 4 to 25 percent.

Elevation ranges from 5,000 to 7,000 feet. The average annual precipitation ranges from 14 to 20 inches, and the mean annual air temperature ranges from 42° to 45° F. The frost-free period is 85 to 100 days. Vegetation is dominantly oakbrush, mulesear dock, and perennial grasses.

In a representative profile the surface layer is about 10 inches thick. The upper 2 inches is very dark grayish-brown silt loam, the next 4 inches is very dark grayish-brown silty clay, and the lower 4 inches is brown clay. To a depth of about 36 inches the substratum is brown clay. Below this to a depth of 65 inches it is light-gray and very pale brown silty clay loam and white sandy clay loam.

The Obrast soils are slightly calcareous to moderately calcareous above a depth of 30 inches and moderately calcareous to strongly calcareous below. Permeability is very slow.

Obrast soils are used mainly as range. Some areas are used for nonirrigated alfalfa and grass.

Representative profile of Obrast silty clay, 4 to 25 percent slopes, in a range area about 1¼ miles due west of Thistle, about 1,320 feet west and 660 feet north of the southeast corner of sec. 30, T. 9 S., R. 4 E., Utah County:

- A11—0 to 2 inches, very dark grayish-brown (10YR 3/2) silt loam, very dark brown (10YR 2/2) when moist; moderate, medium, granular structure; slightly hard, friable, slightly sticky and plastic; few fine, very fine, and coarse roots; common very fine pores; neutral (pH 7.0); abrupt, smooth boundary.
- A12—2 to 6 inches, very dark grayish-brown (10YR 3/2) silty clay, very dark brown (10YR 2/2) when moist; moderate, medium, subangular blocky structure; very hard, firm, sticky and plastic; few very fine and few coarse roots; few fine and medium pores; neutral (pH 7.0); gradual, smooth boundary.
- A13—6 to 10 inches, brown (10YR 4/3) clay, dark brown (10YR 3/3) when moist; moderate, medium, prismatic structure parting to strong, angular blocky; extremely hard, very firm, very sticky and very plastic; few fine and coarse roots; few very fine pores; few slickensides and wedge shaped peds at a 10 to 15 degree angle; neutral (pH 7.0); gradual, smooth boundary.
- C1—10 to 15 inches, brown (10YR 5/3) clay, dark brown (10YR 3/3) when moist; moderate, medium, prismatic structure parting to strong, angular blocky; extremely hard, very firm, very sticky and very plastic; few fine and coarse roots; few very fine pores; common slickensides and wedge shaped peds at a 10 to 15 degree angle; neutral (pH 7.0); gradual, wavy boundary.
- C2—15 to 36 inches, brown (10YR 5/3) clay, brown (10YR 4/3) when moist; moderate, medium, prismatic structure parting to strong, angular blocky; extremely hard, very firm, very sticky and very plastic; few fine and few coarse roots; few fine pores; common slickensides and wedge shaped peds at a 10 to 15 degree angle; 25 to 30 percent of horizon darkened by mixing with dark-colored surface soil; slightly calcareous, lime in fine veins; neutral (pH 7.0); clear, smooth boundary.
- C3—36 to 46 inches, light-gray (10YR 7/2) silty clay loam, light brownish gray (10YR 6/2) when moist; massive; very hard, very firm, sticky and plastic; strongly calcareous, lime in soft rounded masses; moderately alkaline (pH 8.0); clear, smooth boundary.
- C4—46 to 56 inches very pale brown (10YR 7/3) heavy silty clay loam, pale brown (10YR 6/3) when moist; massive; very hard, very firm, sticky and plastic; moderately calcareous, lime in soft rounded masses; moderately alkaline (pH 8.2); clear, smooth boundary.
- C5—56 to 65 inches, white (10YR 8/2) sandy clay loam, light brown (10YR 6/2) when moist; massive; hard, firm, sticky and plastic; strongly calcareous, lime in soft rounded masses; strongly alkaline (pH 8.8).

Depth to shale bedrock is 40 inches or more. When dry these soils crack. Cracks are ½ inch to 2 inches wide and extend to a depth of 40 inches or more. Texture between depths of 10 and 40 inches is clay or silty clay. Content of rock fragments is as much as 15 percent.

The A horizon is 5 to 15 inches thick. It is very dark grayish brown or dark brown to brown, dark grayish brown, or grayish brown when dry and very dark brown, dark brown, or very dark grayish brown when moist. The A horizon is noncalcareous to moderately calcareous, and reaction ranges from neutral to moderately alkaline.

The C horizon is brown, reddish brown, light reddish brown, or pink, light brown, grayish brown, light grayish brown, light gray, very pale brown, or white when dry and dark brown, brown, dark reddish brown or reddish brown, dark grayish brown, grayish brown, pale brown, or light

brownish gray when moist. Slickensides are common to many. Reaction is neutral to strongly alkaline. Content of cobbles and shale fragments ranges from 0 to 30 percent below a depth of 40 inches and there is shale bedrock in some places.

ObC—Obrast clay loam, low rainfall, 2 to 8 percent slopes. This soil is on alluvial fans in an area where the average annual precipitation is 14 to 16 inches. Runoff is slow, and the hazard of erosion is slight. The available water capacity is 8 to 12 inches. The water-supplying capacity is 9 to 11 inches annually. The effective root zone is 60 inches or more.

Included with this soil in mapping are small areas of Deer Creek stony silty loam, 6 to 30 percent slopes, and Toehead silt loam, thin surface variant, 4 to 20 percent slopes.

This soil is used for nonirrigated alfalfa and grass for pasture. It is also used as range. Capability unit IIIe-U nonirrigated; Upland Clay range site.

OCD—Obrast silty clay, 4 to 25 percent slopes. This soil is on mountainsides and alluvial fans. It has the profile described as representative of the series. Runoff is medium, and the hazard of erosion is moderate. The average annual precipitation is 16 to 20 inches, and the available water capacity is 8 to 12 inches. The water-supplying capacity is 11 to 14 inches annually. The effective root zone is about 60 inches.

Included with this soil in mapping are small areas of Mower clay loam, 5 to 30 percent slopes; Ant Flat stony loam, 25 to 40 percent slopes; and Obrast silty clay, shale substratum, 8 to 25 percent slopes.

This soil is used as spring and summer range by sheep, cattle, and deer. Capability unit VIe-M nonirrigated; Mountain Clay range site.

ODD—Obrast silty clay, shale substratum, 8 to 25 percent slopes. This soil is on mountainsides. It has a profile similar to the one described as representative of the series, but shale bedrock is at a depth of 40 to 60 inches. Runoff is medium, and the hazard of erosion is moderate. The hazards of landslide and soil creep are high. During periods of high precipitation the soil becomes saturated with water at the contact with the underlying impermeable shale. This water provides the lubrication for sliding. The average annual precipitation ranges from 16 to 20 inches. The available water capacity is 5 to 8 inches. The water-supplying capacity is 9 to 12 inches annually. Roots penetrate 40 to 60 inches or to shale.

Included with this soil in mapping are small areas of an unnamed soil that has shale bedrock above a depth of 40 inches and Obrast silty clay, 4 to 25 percent slopes.

This soil is used as summer range by sheep, cattle, deer, and elk. Capability unit VIe-M nonirrigated; Mountain Clay range site.

Pavant Series

The Pavant series consists of well-drained soils 10 to 20 inches deep over an indurated lime hardpan. These soils formed in alluvium derived from limestone and sandstone on alluvial fans. Pavant soils are commonly associated with Borvant, Donnardo, Doyce, and Mountainville soils. Slope is 4 to 8 percent.

Elevation ranges from 5,800 to 6,300 feet. The average annual precipitation ranges from 12 to 14 inches, and the mean annual air temperature ranges from 45° to 50° F. The frost-free period is 110 to 120 days. Vegetation is big sagebrush, juniper, pinon, Mormon tea, and perennial grasses.

In a representative profile the surface layer is dark-brown loam about 7 inches thick. The substratum is dark-brown light clay loam about 10 inches thick over an indurated lime hardpan.

Reaction is mildly alkaline to moderately alkaline. Permeability is slow. The available water capacity is 2 to 3 inches. The water-supplying capacity is 4 to 5 inches annually. Roots penetrate 10 to 20 inches to the top of the hardpan.

Pavant soils are used as range or pasture.

Representative profile of Pavant loam, 4 to 8 percent slopes, in a pasture area, about $\frac{3}{4}$ mile north of the Spring City Power Plant, about 1,815 feet east and 2,000 feet south of the northwest corner of sec. 35, T. 15 S., R. 4 E., Sanpete County:

Ap1—0 to 2 inches, dark-brown (10YR 4/3) loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, subangular blocky structure; hard, friable, slightly sticky and plastic; many very fine roots; few fine pores; slightly calcareous; mildly alkaline (pH 7.8); abrupt, smooth boundary.

Ap2—2 to 7 inches, dark-brown (7.5YR 4/3) loam, dark brown (7.5YR 3/2) when moist; weak, medium, subangular blocky structure; hard, friable, slightly sticky and plastic; common very fine and few fine roots; common fine and few medium pores; slightly calcareous; mildly alkaline (pH 7.6); clear, smooth boundary.

C1—7 to 13 inches, dark-brown (7.5YR 4/3) light clay loam, dark brown (7.5YR 3/2) when moist; weak, medium, prismatic structure parting to moderate, medium, subangular blocky; hard, firm, sticky and plastic; common very fine and few medium roots; few fine and medium pores; slightly calcareous; mildly alkaline (pH 7.8); gradual, wavy boundary.

C1ca—13 to 17 inches, dark-brown (7.5YR 4/3) light clay loam, dark brown (7.5YR 3/2) when moist; massive; hard, firm, sticky and plastic; few very fine roots; few fine pores; moderately calcareous, lime in soft masses; mildly alkaline (pH 7.8); abrupt, wavy boundary.

C2cam—17 to 25 inches, two platy indurated layers of lime-cemented hardpan 2 to 4 inches thick with distinct laminae surfaces, separated by $\frac{1}{2}$ - to 2-inch layers of loam between the cemented layers.

C3cam—25 inches, indurated lime cemented hardpan.

Depth to the indurated lime hardpan ranges from 10 to 20 inches. Texture between a depth of 10 inches and the hardpan ranges from loam to light clay loam. Content of gravel ranges from few to 20 percent.

The A horizon is 7 to 9 inches thick. It is dark brown, brown, grayish brown, or dark grayish brown when dry and dark brown or very dark grayish brown when moist. The A horizon is slightly calcareous to moderately calcareous, and reaction is mildly alkaline to moderately alkaline.

The Cca horizon is dark brown, dark grayish brown, brown, grayish brown, light brown, or light brownish gray to pale brown or very pale brown when dry and dark brown, brown, or very dark grayish brown to light brownish gray or light brown when moist. The Cca horizon is moderately calcareous to strongly calcareous, and reaction is mildly alkaline to moderately alkaline.

PaC—Pavant loam, 4 to 8 percent slopes. This soil is on alluvial fans (fig. 10). It has the profile described as representative of the series. Runoff is medium, and the hazard of erosion is moderate.



Figure 10.—Pavant loam, 4 to 8 percent slopes. The indurated hardpan is at a depth of about 17 inches.

Included with this soil in mapping are small areas of Mountainville very stony sandy loam, 2 to 8 percent slopes; Doyce loam, 4 to 8 percent slopes; and Donnardo very stony loam, 4 to 16 percent slopes.

This soil is used as range by sheep and cattle and winter range for deer. Capability unit VII_s-U nonirrigated; Upland Shallow Hardpan (Juniper-Pinon) range site.

PDC—Pavant-Doyce complex, 2 to 8 percent slopes. This mapping unit is in fairly large areas on alluvial fans. It is about 35 percent Pavant loam, 4 to 8 percent slopes, on the stone-free side slopes; 35 percent Doyce loam, 2 to 4 percent slopes, in swales and less sloping areas; and about 15 percent each Borvant very stony loam, 2 to 10 percent slopes, and Donnardo very stony loam, 4 to 16 percent slopes, on ridges.

Runoff is medium on the Pavant soils, and the hazard of erosion is moderate. Runoff is slow on the Doyce soils, and the hazard of erosion is moderate.

This mapping unit is used as spring and fall range by sheep and cattle and as winter range by deer. Capability unit VI_s-U nonirrigated; Pavant soil in Upland Shallow Hardpan (Juniper-Pinon) range site, Doyce soil in Upland Loam range site.

Peteetneet Series

The Peteetneet series consists of very poorly drained organic soils that formed in organic materials derived from marsh type plants on valley bottoms. Peteetneet soils are commonly associated with Abcal, Kjar, Poganeab, and Shumway soils. Slope is 0 to 3 percent.

Elevation ranges from 5,400 to 5,500 feet. The average annual precipitation ranges from 11 to 12 inches, and the mean annual air temperature ranges from 49° to 50° F. The frost-free period is about 120 days. Vegetation is cattails, rushes, reeds, and sedges.

In a representative profile the surface layer is dark-gray peat about 6 inches thick. Below this to a depth of 60 inches is dominantly very dark gray, gray, or black muck, with a thin layer of gray clay between depths of 23 and 26 inches.

Reaction is mildly alkaline to moderately alkaline. Permeability is moderate. The available water capacity is 11 to 14 inches. The effective root zone is 60 inches or more. The seasonal water table is ponded on the surface in spring but fluctuates to a depth of 40 to 60 inches in dry years.

Peteetneet soils are used for pasture and native hay.

Representative profile of Peteetneet peat, in a pasture 2¾ miles west of the railroad tracks in Ephraim, 2,145 feet west and 35 feet south of the northeast corner of sec. 12, T. 17 S., R. 2 E., Sanpete County:

Oa1—0 to 6 inches, dark-gray (N 4/0) peat, very dark gray (N 3/0) when moist; hard, firm, nonsticky and nonplastic; moderately calcareous; moderately alkaline (pH 8.2); clear, smooth boundary.

Oa2—6 to 16 inches, very dark gray (N 3/0) muck, black (N 2/0) when moist; hard, friable, nonsticky and nonplastic; moderately calcareous; common snail shells; moderately alkaline (pH 8.0); clear, smooth boundary.

Oa3—16 to 23 inches, very dark gray (N 3/0) muck, black (N 2/0) when moist; hard, friable, nonsticky and nonplastic; slightly calcareous; mildly alkaline (pH 7.8); abrupt, smooth boundary.

IIC—23 to 26 inches, gray (N 5/0) clay, very dark gray (N 3/0) when moist; massive; very hard, very firm, sticky and plastic; strongly calcareous; common snail shells; mildly alkaline (pH 7.8); abrupt, smooth boundary.

Oa4—26 to 36 inches, very dark gray (N 3/0) muck,

black (N 2/0) when moist; hard, very friable, nonsticky and nonplastic; slightly calcareous; common snail shells; mildly alkaline (pH 7.6); clear, smooth boundary.

Oa5—36 to 48 inches, black (N 2/0) muck, black (N 2/0) when moist; hard, friable, nonsticky and nonplastic; noncalcareous; mildly alkaline (pH 7.6); clear, smooth boundary.

Oa6—48 to 60 inches, very dark gray (N 3/0) muck, black (N 2/0) when moist; slightly hard, very friable, nonsticky and nonplastic; strongly calcareous; common snail shells; moderately alkaline (pH 8.0).

Texture between depths of 12 and 35 inches is typically muck and the fiber content is less than one-third, by volume, of the organic matter. Thin strata of mineral soil ½ to 3 inches in thickness are also typical between these depths. The soil is noncalcareous to strongly calcareous, and reaction is mildly alkaline to moderately alkaline. The soil ranges from black to gray when dry and from black to very dark gray when moist.

Pe—Peteetneet peat. This soil is on flood plains on valley bottoms. Runoff is very slow, and there is no hazard of erosion. Flooding causes the surface layer to be mineral in places.

Included with this soil in mapping are small areas of Kjar peaty silt loam; Shumway silty clay loam; and Abcal silty clay loam.

This soil is used for pasture and as range. Seeding of adapted grasses has been successful. Capability unit Vw-2 nonirrigated; Wet Meadows range site.

Poganeab Series

The Poganeab series consists of poorly drained soils that formed in alluvium derived from shale, limestone, and sandstone on flood plains and valley bottoms. Poganeab soils are commonly associated with Kjar, Anco, Shumway, and Dyreng soils. Slope is 0 to 2 percent.

Elevation ranges from 5,100 to 5,600 feet. The average annual precipitation ranges from 8 to 12 inches, and the mean annual air temperature ranges from 46° to 52° F. The frost-free period ranges from 110 to 125 days. Vegetation is foxtail, wiregrass, and sedges.

In a representative profile the surface layer is gray and light brownish-gray silt loam and silty clay loam about 11 inches thick. The substratum to a depth of 60 inches is light-gray silty clay loam and silty clay.

The Poganeab soils are strongly calcareous, and reaction is moderately alkaline to strongly alkaline. Some of the soils are strongly saline-alkali. Permeability is moderately slow. The effective root zone is 60 inches or more. The seasonal water table fluctuates from the surface to a depth of 40 inches.

Poganeab soils are used for pasture and native hay.

Representative profile of Poganeab silt loam, in a pasture area 1 mile south and 1¼ miles west of Chester, about 1,155 feet west and 330 feet south of the northeast corner of sec. 4, T. 16 S., R. 3 E., Sanpete County:

A11—0 to 2 inches, light brownish-gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure; slightly hard, friable, slightly sticky and plastic; many very fine and few fine roots; few very fine pores; strongly calcareous; strongly alkaline (pH 9.0); abrupt, wavy boundary.

A12—2 to 5 inches, gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) when moist; common, coarse, distinct, black (N 1/0) mottles; weak, thick, platy structure

parting to weak, fine, granular; slightly hard, friable, slightly sticky and plastic; common very fine and few fine roots; few very fine pores; strongly calcareous; strongly alkaline (pH 8.8); clear, wavy boundary.

A13—5 to 11 inches, gray (10YR 6/1) silty clay loam, dark gray (10YR 4/1) when moist; few, coarse, distinct, very dark gray (N 3/0) mottles; weak, fine, subangular blocky structure; slightly hard, firm, slightly sticky and plastic; common very fine and fine roots; few fine and very fine pores; strongly calcareous; strongly alkaline (pH 8.8); clear, wavy boundary.

C1—11 to 21 inches, light-gray (10YR 7/1) silty clay loam, gray (10YR 5/1) when moist; few, medium, distinct, olive-yellow (2.5Y 6/6) mottles; slightly hard, firm, slightly sticky and plastic; common fine and very fine roots; strongly calcareous; strongly alkaline (pH 8.6); gradual, smooth boundary.

C2—21 to 37 inches, light-gray (10YR 7/1) silty clay loam, gray (10YR 5/1) when moist; moderate, fine, subangular blocky structure; hard, firm, sticky and plastic; few fine and very fine roots; few fine and very fine pores; strongly calcareous; strongly alkaline (pH 9.0); gradual, smooth boundary.

C3—37 to 50 inches, light-gray (10YR 7/2) silty clay loam, gray (10YR 5/1) when moist; massive; hard, firm, sticky and plastic; few fine roots; few fine and very fine pores; strongly calcareous; strongly alkaline (pH 9.0); clear, wavy boundary.

C4—50 to 60 inches, light-gray (10YR 7/1) silty clay, dark gray (10YR 4/1) when moist; massive; very hard, very firm, sticky and plastic; few very fine and fine roots; few fine and very fine pores; strongly calcareous; strongly alkaline (pH 9.0).

The soil is more than 60 inches deep. Distinct or prominent mottles are above a depth of 20 inches, or the matrix is gray or dark gray when moist. The soil is typically silty clay loam or clay loam between depths of 10 and 40 inches, but there is thin stratification of sandy loam to clay in places.

The A horizon is 6 to 11 inches thick. It is grayish brown or light brownish gray to gray or light gray when dry and dark gray or dark grayish brown to gray or grayish brown when moist. The A horizon ranges from nonsaline to strongly saline.

The C horizon is grayish brown, gray, or light brownish gray to gray or light gray when dry and dark gray or dark grayish brown to gray or grayish brown when moist.

Pg—Poganeab silt loam. This soil is on flood plains and valley bottoms. It has the profile described as representative of the series. Slope is 0 to 2 percent. Runoff is slow, and the hazard of erosion is none to slight. The available water capacity is 8 to 12 inches.

Included with this soil in mapping are small areas of Poganeab silt loam, strongly saline-alkali; Abcal silty clay loam; and Shumway silty clay loam.

This soil is used for pasture and for native wild hay. It is also used as a nesting area and habitat by upland game birds and waterfowl. Capability unit Vw-2 non-irrigated; Wet Meadows range site.

Ph—Poganeab silt loam, strongly saline-alkali. This soil is on flood plains and valley bottoms. It has a profile similar to the one described as representative of the series, but it is strongly saline-alkali affected. Slope is 0 to 2 percent. Runoff is slow, and the hazard of erosion is none to slight. The available water capacity is 2 to 3 inches. The high salt content reduces the water available to plants.

Included with this soil in mapping are small areas of Poganeab silt loam; Abcal silty clay loam, strongly saline; and Anco silty clay loam.

This soil is used as range or pasture. It is also used as a nesting area and habitat by upland game birds.

Capability unit VIIw-28 nonirrigated; Salt Meadows range site.

Poganeab Variant

The Poganeab variant consists of poorly drained soils that formed in alluvium derived from shale and limestone on flood plains and valley bottoms. The Poganeab variant is most commonly associated with Chipman and Beek soils. Slope is 0 to 2 percent.

Elevation ranges from 5,600 to 6,000 feet. The average annual precipitation ranges from 12 to 14 inches, and the mean annual air temperature ranges from 45° to 47° F. The frost-free period is 110 to 120 days. Vegetation is foxtail, wiregrass, and sedges.

In a representative profile the surface layer is gray and light-gray silt loam about 12 inches thick. The substratum to a depth of 60 inches is light-gray silty clay loam and silt loam.

The Poganeab variant is very strongly calcareous. Permeability is moderately slow. The available water capacity is 7 to 9 inches. These soils are moderately saline to strongly saline. The content of salt reduces the amount of water available to plants. The effective root zone is 60 inches or more. The depth to seasonal water table ranges from 20 to 36 inches.

Poganeab variant soils are used for native pasture and hay.

Representative profile of Poganeab silt loam, high lime variant, in a pasture area about 2 miles north and 1½ miles west of Moroni, about 1,815 feet east and 2,600 feet north of the southwest corner of sec. 29, T. 14 S., R. 3 E., Sanpete County:

A11—0 to 2 inches, gray (10YR 5/1) silt loam, dark gray (10YR 4/1) when moist; weak, fine, granular structure; hard, friable, slightly sticky and plastic; many very fine roots; few fine pores; strongly calcareous; strongly alkaline (pH 8.8); abrupt, smooth boundary.

A12—2 to 12 inches, light-gray (10YR 6/1) silt loam, dark gray (10YR 4/1) when moist; moderate, medium, subangular blocky structure; hard, firm, sticky and plastic; common very fine roots; few fine pores; strongly calcareous; strongly alkaline (pH 8.6); clear, smooth boundary.

C1ca—12 to 17 inches, light-gray (10YR 7/1) silty clay loam, gray (10YR 5/1) when moist; massive; hard, firm, sticky and plastic; few fine and very fine roots; very strongly calcareous, lime in fine soft rounded masses; strongly alkaline (pH 8.8); gradual, smooth boundary.

C2ca—17 to 28 inches, light-gray (10YR 6/1) silt loam, gray (10YR 5/1) when moist; massive; slightly hard, friable, slightly sticky and plastic; very strongly calcareous, lime in fine soft rounded masses; strongly alkaline (pH 8.6); gradual, smooth boundary.

C3ca—28 to 60 inches, light-gray (10YR 7/1) silt loam, gray (10YR 5/1) when moist; massive; slightly hard, friable, slightly sticky and plastic; very strongly calcareous, lime in fine soft rounded masses; strongly alkaline (pH 8.8).

The soil is more than 60 inches thick. Distinct or prominent mottles are above a depth of 20 inches, or the matrix is gray or dark gray when moist. The soil is silt loam to silty clay loam between depths of 10 and 40 inches.

The A horizon is 9 to 12 inches thick. It is gray to light gray or light brownish gray when dry and dark gray to very dark grayish brown when moist. The A horizon is strongly calcareous to very strongly calcareous, and reaction is moderately alkaline to strongly alkaline.

The Cca horizon is light gray to gray. Reaction is strongly alkaline to very strongly alkaline.

Pk—Poganeab silt loam, high lime variant. This soil is on flood plains and in valley bottoms. Runoff is slow, and the hazard of erosion is none to slight.

Included with this soil in mapping are small areas of Chipman silty clay loam and Beek silty clay loam.

This soil is used for pasture, native or wild hay, or as range. It is also used as a nesting area and habitat by upland game birds. Capability unit Vw-2 nonirrigated; Wet Meadows range site.

Pritchett Series

The Pritchett series consists of well-drained soils that formed in local colluvium and residuum derived from sandstone and quartzite on mountainsides. Pritchett soils are commonly associated with Mortenson, Skylick, Tingey, and Toze soils. Slope is 20 to 70 percent.

Elevation ranges from 7,000 to 8,900 feet. The average annual precipitation ranges from 22 to 30 inches, and the mean annual air temperature ranges from 36° to 40° F. The frost-free period is 70 to 90 days. Vegetation is mainly aspen, scattered conifers, oakbrush, and perennial grasses.

In a representative profile the surface layer is about 16 inches thick. It is dark-brown silt loam in the upper 12 inches and brown stony silt loam in the lower 4 inches. The subsurface layer is pale-brown very stony very fine sandy loam about 8 inches thick. The subsoil to a depth of about 60 inches is pale-brown stony and very stony clay.

Reaction is medium acid to neutral. Permeability is moderately slow. The available water capacity is 5 to 7 inches. The water-supplying capacity is 14 to 18 inches annually. The effective root zone is about 60 inches.

Pritchett soils are used as summer range by sheep, cattle, deer, and elk. They are also used for woodland and are valuable as water catchment areas for watersheds.

Representative profile of Pritchett silt loam, 20 to 40 percent slopes, in a range area $\frac{3}{4}$ mile east of Pritchett Flat, about 1,320 feet west and 200 feet north of the southeast corner of sec. 27, T. 14 S., R. 5 E., Sanpete County:

A11—0 to 3 inches, dark-brown (10YR 4/3) silt loam, very dark brown (10YR 2/2) when moist; moderate, fine, granular structure; slightly hard, friable, slightly sticky and nonplastic; common very fine roots; common fine pores; 15 percent stones and cobbles; slightly acid (pH 6.4); clear, smooth boundary.

A12—3 to 12 inches, dark-brown (10YR 4/3) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, subangular blocky structure; hard, firm, slightly sticky and slightly plastic; few fine, medium, and large roots; few fine and medium pores; 15 percent stones and cobbles; slightly acid (pH 6.4); clear, smooth boundary.

A13—12 to 16 inches, brown (10YR 5/3) stony silt loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, subangular blocky structure; very hard, firm, slightly sticky and slightly plastic; few coarse, medium, and fine roots; few fine pores; 40 percent stones and cobbles; slightly acid (pH 6.2); clear, wavy boundary.

A21—16 to 24 inches, pale-brown (10YR 6/3) very stony very fine sandy loam, brown (10YR 5/3) when moist; weak, medium, subangular blocky structure; hard, friable, nonsticky and slightly plastic; few fine, me-

dium, and coarse roots; few fine pores; 60 percent cobbles and stones; medium acid (pH 6.0); clear, smooth boundary.

B21t—24 to 42 inches, pale-brown (10YR 6/3) stony clay, brown (10YR 5/3) when moist; strong, medium, angular blocky structure; extremely hard, very firm, sticky and plastic; few fine and very fine roots; few fine pores; common moderately thick clay films; 40 percent cobbles and stones; medium acid (pH 6.0); gradual, smooth boundary.

B22t—42 to 60 inches, pale-brown (10YR 6/3) very stony clay, brown (10YR 5/3) when moist; strong, medium, angular blocky structure; extremely hard, very firm, sticky and plastic; few fine and very fine roots; few fine pores; common, moderately thick clay films; 60 percent cobbles and stones; medium acid (pH 6.0).

The soil is 60 inches or more deep.

The A1 horizon is 10 to 16 inches thick. It is dark brown or very dark grayish brown to dark grayish brown or brown when dry and very dark grayish brown, very dark brown, or dark brown when moist. The A1 horizon ranges from silt loam or stony silt loam to stony fine sandy loam and contains 15 to 40 percent rock fragments.

The A2 horizon is 4 to 12 inches thick. It is pale brown, brown, or light brown to grayish brown or light brownish gray when dry and brown or dark brown to dark grayish brown or grayish brown when moist. The A2 horizon ranges from very cobbly or very stony very fine sandy loam to very cobbly or very stony fine sandy loam. Reaction in the A1 and A2 horizons ranges from slightly acid to neutral.

The B2t horizon is pale brown, brown, light brown, pink, very pale brown, yellowish brown, or light yellowish brown when dry and brown, dark brown, or light brown to brown, pale brown, light yellowish brown, or yellowish brown when moist. The B2t horizon ranges from cobbly, very cobbly, or very stony heavy sandy clay loam to cobbly, very stony, or very cobbly clay and contains 35 to 70 percent cobbles, stones, and gravel. Reaction ranges from medium acid to neutral.

PRF—Pritchett stony fine sandy loam, 30 to 70 percent slopes. This soil is on southern exposures of mountainsides. It has a profile similar to the one described as representative of the series, but texture of the surface layer is fine sandy loam and stones cover 10 to 25 percent of the surface in places. Runoff is medium, and the hazard of erosion is moderate. Vegetation is characteristically oakbrush and scattered aspen and conifer.

Included with this soil in mapping are small areas of Tingey stony silt loam, 40 to 70 percent slopes, and Rock outcrop.

This soil is used as summer range by sheep, cattle, deer, and elk. Capability unit VIIe-H nonirrigated; High Mountain Loam range site.

PTE—Pritchett silt loam, 20 to 40 percent slopes. This soil is on northern exposures of mountainsides. It has the profile described as representative of the series. Runoff is medium, and the hazard of erosion is slight. Vegetation is dominantly aspen and scattered conifer.

Included with this soil in mapping are small areas of Mortenson silt loam, 40 to 70 percent slopes, and Skylick silt loam, 4 to 30 percent slopes. Stones cover 1 to 2 percent of the surface in places.

This soil is used as summer range by sheep, cattle, deer, and elk. It is also used for aspen woodland.

This soil has a site index of about 56 for aspen. The average annual production is about 13 cubic feet of cordwood or 7.5 board feet of sawtimber per acre. Windthrow hazard and plant competition are slight, and seedling mortality and equipment restriction are

moderate. Capability unit VIe-H nonirrigated; High Mountain Loam (Aspen) range site.

Quaker Series

The Quaker series consists of well-drained soils that formed in alluvium derived from limestone and shale on alluvial fans and alluvial plains. Quaker soils are commonly associated with Ephraim, Genola, Mellor, and Sanpete soils. Slope is 1 to 5 percent.

Elevation ranges from 5,400 to 6,500 feet. The average annual precipitation ranges from 8 to 12 inches, and the mean annual air temperature ranges from 45° to 50° F. The frost-free period is 115 to 130 days. Vegetation is mainly big sagebrush, rubber rabbitbrush, and perennial grasses.

In a representative profile the surface layer is pale-brown silty clay loam about 7 inches thick. The substratum to a depth of 60 inches is pale-brown and very pale brown silty clay loam and very pale brown gravelly clay loam and sandy clay loam.

The Quaker soils are very strongly calcareous, and reaction is moderately alkaline to very strongly alkaline. Some of the soils are very strongly saline. Permeability is moderately slow. The effective root zone is about 60 inches.

Quaker soils are used for irrigated and nonirrigated alfalfa, small grain, and pasture. They are also used as range.

Representative profile of Quaker silty clay loam, 2 to 5 percent slopes, in a range area 5 miles south of Spring City, about 1,200 feet south and 200 feet east of the northwest corner of sec. 19, T. 16 S., R. 4 E., Sanpete County:

- A11—0 to 2 inches, pale-brown (10YR 6/3) silty clay loam, brown (10YR 4/3) when moist; moderate, fine, granular structure; slightly hard, firm, sticky and plastic; few very fine roots; few medium, fine, and common very fine vesicular pores; strongly calcareous; moderately alkaline (pH 8.0); abrupt, smooth boundary.
- A12—2 to 7 inches, pale-brown (10YR 6/3) silty clay loam, brown (10YR 4/3) when moist; weak, medium, subangular blocky structure; hard, firm, sticky and plastic; few very fine, few medium pores; strongly calcareous; mildly alkaline (pH 7.8); clear, smooth boundary.
- C1—7 to 13 inches, pale-brown (10YR 6/3) silty clay loam, dark brown (10YR 4/3) when moist; moderate, fine, subangular blocky structure; hard, firm, sticky and plastic; few fine and very fine roots; common very fine and few fine and medium pores; strongly calcareous; moderately alkaline (pH 8.2); clear, smooth boundary.
- C2—13 to 23 inches, very pale brown (10YR 7/3) silty clay loam, brown (10YR 5/3) when moist; moderate, medium, subangular blocky structure; hard, firm, sticky and plastic; few fine and very fine roots; few fine, very fine, and medium pores; very strongly calcareous, lime in few fine veins; strongly alkaline (pH 8.6); gradual, smooth boundary.
- C3—23 to 33 inches, very pale brown (10YR 7/3) silty clay loam, brown (10YR 5/3) when moist; weak, coarse, subangular blocky structure; hard, firm, sticky and plastic; few fine and very fine roots; common very fine pores; very strongly calcareous, lime in few fine veins; strongly alkaline (pH 8.6); clear, smooth boundary.
- C4—33 to 50 inches, very pale brown (10YR 7/3) silty clay loam, brown (10YR 5/3) when moist; massive; hard, firm, slightly sticky and plastic; few fine and very fine roots; common very fine and few fine pores; layer of gravelly material 2 inches thick; very strongly

calcareous, lime in few fine veins; strongly alkaline (pH 8.6); clear, wavy boundary.

- C5—50 to 57 inches, very pale brown (10YR 7/3) gravelly light clay loam, brown (10YR 5/3) when moist; massive; slightly hard, firm, slightly sticky and plastic; few fine and very fine roots; common very fine pores; 25 percent gravel; very strongly calcareous, lime in fine veins; strongly alkaline (pH 8.6); clear, wavy boundary.

- C6—57 to 60 inches, very pale brown (10YR 7/3) sandy clay loam, brown (10YR 5/3) when moist; massive; slightly hard, firm, slightly sticky and plastic; few very fine roots; common very fine pores; very strongly calcareous; strongly alkaline (pH 9.0).

The soil is more than 60 inches deep. Between depths of 10 and 40 inches, it is typically silty clay loam or clay loam but ranges to silty clay in thin strata. Salinity ranges from nonsaline to strongly saline.

The A horizon is 5 to 10 inches thick. It is pale brown, brown, light brown, or pink to grayish brown, light brownish gray, or very pale brown when dry and brown or dark brown to very dark grayish brown, dark grayish brown, or grayish brown when moist.

The C horizon is pale brown, very pale brown, light brown, pinkish gray, or pink to light brownish gray when dry and dark brown, brown, or light brown to dark grayish brown, grayish brown, or light grayish brown when moist.

QkB—Quaker silty clay loam, 1 to 2 percent slopes. This soil is on alluvial fans and alluvial plains. Runoff is medium, and the hazard of erosion is moderate. The average annual precipitation is 8 to 10 inches. The available water capacity is 5 to 8 inches. The high lime content of this soil influences the available water capacity. The water-supplying capacity is 5 to 8 inches annually.

Included with this soil in mapping are small areas of Woodrow silty clay loam, 0 to 2 percent slopes; Quaker silty clay loam, 2 to 5 percent slopes; Genola loam, 0 to 2 percent slopes; and a soil that is similar to the Quaker soil in texture but is olive or yellow.

This soil is used for irrigated alfalfa, small grain, and pasture. Small areas are used as range. Capability units IIe-2 irrigated, VIIe-S nonirrigated; Semi-desert Loam range site.

QkC—Quaker silty clay loam, 2 to 5 percent slopes. This soil is on alluvial fans and alluvial plains. It has the profile described as representative of the series. Runoff is medium, and the hazard of erosion is severe. The average annual precipitation is 10 to 12 inches, and the available water capacity is 5 to 8 inches. The water-supplying capacity is 7 to 9 inches annually. The high lime content of this soil influences the water holding capacity.

Included with this soil in mapping are small areas of Woodrow silty clay loam, 0 to 2 percent slopes; Quaker silty clay loam, 1 to 2 percent slopes; and Genola loam, 2 to 5 percent slopes.

This soil is used for irrigated and nonirrigated alfalfa, small grain, and pasture. Small areas are used as range. Capability units IIIe-2 irrigated, VIe-S nonirrigated; Semi-desert Loam range site.

Qm—Quaker and Mellor soils. This mapping unit is on alluvial fans and alluvial plains. It is about 60 percent Quaker silty clay loam, strongly saline-alkali, 1 to 5 percent slopes; 30 percent Mellor silt loam; about 5 percent each Harding silt loam and Manassa silty clay loam; and small areas of Genola loam, alkali, 0 to 2 percent slopes. These soils are not usually in a

regular pattern, but in places the Mellor soils are in the slightly higher lying areas. Quaker soils are in swales or depressions. Both soils are not always present.

The Quaker soil has a profile similar to the one described as representative of the series, but it is strongly saline-alkali affected above a depth of 20 inches. Runoff is medium, and the hazard of erosion ranges from moderate to severe. The available water capacity is about 2 inches. The high salt content reduces the amount of water available to plants. The water-supplying capacity is less than 4 inches annually. Runoff is rapid on the Mellor soil, and the hazard of erosion is severe. Vegetation is mainly greasewood.

This mapping unit is used as early spring and late fall range by sheep and cattle. It is also used as habitat by upland game birds. Capability unit VII_s-S8 non-irrigated; Semi-desert Alkali Flats range site.

Rapho Series

The Rapho series consists of somewhat excessively drained soils that formed in alluvium derived from limestone, sandstone, and shale on alluvial fans and alluvial plains. Rapho soils are most commonly associated with Arapien, Genola, Linoyer, Sanpete, and Sigurd soils. Slopes are typically smooth and are 2 to 10 percent.

Elevation ranges from 5,000 to 6,000 feet. The average annual precipitation ranges from 8 to 12 inches, and the mean annual air temperature ranges from 45° to 49° F. The frost-free period ranges from about 115 to 130 days. Vegetation of the noncultivated areas is dominantly big sagebrush, shadscale, rabbitbrush, and perennial grasses.

In a representative profile the surface layer is pale-brown gravelly fine sandy loam about 4 inches thick. The substratum to a depth of 40 inches is pink gravelly very fine sandy loam and pale brown gravelly very fine sandy loam. Below this to a depth of 60 inches it is pale-brown very gravelly sandy loam and very fine sandy loam.

The Rapho soils are strongly calcareous in the surface layer and very strongly calcareous below the surface layer. Reaction is moderately alkaline to strongly alkaline. Permeability is rapid. The available water capacity is 5 to 9 inches. The water-supplying capacity of nonirrigated soils is 5 to 7 inches annually. The effective rooting depth is about 60 inches.

Rapho soils are used for irrigated alfalfa. These soils are used as range and as habitat for upland game birds. They are also a source of road fill.

Representative profile of Rapho gravelly fine sandy loam, 2 to 5 percent slopes, in a range area, 2½ miles west, 1½ miles south of Gunnison, about 1,830 feet south, 427 feet east of the northwest corner of sec. 26, T. 19 S., R. 1 W., Sanpete County:

A1—0 to 4 inches, pale-brown (10YR 6/3) gravelly fine sandy loam, brown (10YR 5/3) when moist; weak, thin, platy structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; few fine and very fine pores; 20 percent gravel; strongly calcareous; moderately alkaline (pH 8.2); clear, smooth boundary.

C1—4 to 11 inches, pink (7.5YR 7/3) gravelly fine sandy

loam, light brown (7.5YR 6/3) when moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; common very fine pores; 25 percent gravel; very strongly calcareous; moderately alkaline (pH 8.2); clear, wavy boundary.

C2—11 to 22 inches, pink (7.5YR 7/3) gravelly light loam, brown (7.5YR 5/3) when moist; massive; loose, friable, slightly sticky and slightly plastic; few very fine roots; few fine and very fine pores; 30 percent gravel; very strongly calcareous; moderately alkaline (pH 8.3); clear, smooth boundary.

C3—22 to 31 inches, pink (7.5YR 7/3) gravelly very fine sandy loam, brown (7.5YR 5/3) when moist; massive; loose, friable, slightly sticky and slightly plastic; few very fine roots; few fine and very fine pores; 25 percent gravel; very strongly calcareous; moderately alkaline (pH 8.4); clear, wavy boundary.

C4—31 to 40 inches, pale-brown (10YR 6/3) gravelly very fine sandy loam, yellowish brown (10YR 5/4) when moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; 20 percent gravel; very strongly calcareous; strongly alkaline (pH 8.5); clear, wavy boundary.

C5—40 to 52 inches, pale-brown (10YR 6/3) very gravelly sandy loam, yellowish brown (10YR 5/4) when moist; massive; soft, very friable, slightly sticky and slightly plastic; few very fine roots; few fine interstitial pores; 50 percent gravel; very strongly calcareous; strongly alkaline (pH 8.6); clear, wavy boundary.

C6—52 to 60 inches, pale-brown (10YR 6/3) very fine sandy loam, yellowish brown (10YR 5/4) when moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; few very fine pores; 5 percent gravel; very strongly calcareous; strongly alkaline (pH 8.6).

The soil is more than 60 inches deep. Texture between depths of 10 and 40 inches is gravelly loam, gravelly very fine sandy loam, or gravelly fine sandy loam. Content of gravel ranges from 20 to 35 percent.

The A horizon is 3 to 12 inches thick. It is pale brown or light brown to very pale brown or light gray when dry and brown, dark brown, or pale brown when moist.

The C horizon is pink, light brown, or pale brown to very pale brown when dry and brown or light brown to dark brown or yellowish brown to pale brown when moist. There is stratification of sandy loam, loam, or silty clay loam at a depth of 40 inches or more, and content of gravel is as much as 55 percent.

RaC—Rapho gravelly fine sandy loam, 2 to 5 percent slopes. This soil is on alluvial fans and alluvial plains. It has the profile described as representative of the series. Slope is 2 to 5 percent. Runoff is medium, and the hazard of erosion is moderate. Moderate sheet and rill erosion and some deep gullies occur.

Included with this soil in mapping are small areas of Linoyer very fine sandy loam, 2 to 5 percent slopes, eroded; Sigurd gravelly loam, 1 to 5 percent slopes; and Sanpete gravelly fine sandy loam, 2 to 5 percent slopes.

Most of the acreage of this soil is used as range. Small areas are used for irrigated alfalfa and small grain. The soil is also a source of road fill. Capability units III_e-2 irrigated, VII_e-S nonirrigated; Semi-desert Loam range site.

RaD—Rapho gravelly fine sandy loam, 5 to 10 percent slopes. This soil is on alluvial fans and alluvial plains. Sheet and rill erosion are moderate, and there are some gullies. Runoff is rapid, and the hazard of erosion is severe.

Included with this soil in mapping are small areas of Sanpete cobbly fine sandy loam, 5 to 10 percent slopes, eroded, and Sigurd cobbly fine sandy loam, 5 to 10 percent slopes, eroded.

This soil is used mainly as range, but small areas are used for irrigated alfalfa and pasture. It is a good source of road fill. Capability units IVe-2 irrigated, VIIe-S nonirrigated; Semi-desert Loam range site.

Ravola Series

The Ravola series consists of well-drained soils that formed in alluvium derived from shale and sandstone on alluvial fans and alluvial plains. Ravola soils are most commonly associated with Billings, Genola, and Mayfield soils and Badlands. Slopes are typically smooth and are 1 to 5 percent.

Elevation ranges from 5,400 to 5,800 feet. The average annual precipitation ranges from 8 to 11 inches, and the mean annual air temperature ranges from 47° to 52° F. The frost-free period ranges from 115 to 180 days. Vegetation in the noncultivated areas is dominantly big sagebrush, shadscale, yellowbrush, greasewood, and perennial grasses.

In a representative profile the surface layer is light yellowish-brown loam about 6 inches thick. The substratum is pale-yellow or light-gray loam to a depth of 60 inches.

The Ravola soils are strongly calcareous, and reaction is moderately alkaline to strongly alkaline. Permeability is moderate. The available water capacity is 8 to 11 inches. The water-supplying capacity of nonirrigated soils is 5 to 7 inches annually. The effective root zone is 60 inches or more.

Ravola soils are used for irrigated alfalfa, small grain, corn for silage, pasture, and as range. They are also used as habitat by upland game birds and small game.

Representative profile of Ravola loam, 2 to 5 percent slopes, in a cultivated field 1 mile northwest of Mayfield near 12 Mile Creek, 1,525 feet south and 670 feet west of the northeast corner of sec. 30, T. 19, S., R. 2 E., Sanpete County:

- AP—0 to 6 inches, light yellowish-brown (2.5Y 6/3) heavy loam, light olive brown (2.5Y 5/3) when moist; weak, medium, subangular blocky structure; hard, friable, slightly sticky and plastic; common very fine, few fine, and medium roots; few very fine, fine, and medium pores; strongly calcareous; moderately alkaline (pH 8.4); clear, smooth boundary.
- C1—6 to 19 inches, pale-yellow (2.5Y 7/3) heavy loam, light olive brown (2.5Y 5/3) when moist; weak, medium, subangular blocky structure; hard, friable, slightly sticky and plastic; few very fine and medium roots; few very fine and medium pores; strongly calcareous; moderately alkaline (pH 8.4); clear, smooth boundary.
- C2—19 to 23 inches, pale-yellow (2.5Y 7/3) heavy loam, light yellowish brown (2.5Y 6/3) when moist; massive; hard, friable, slightly sticky and plastic; few very fine, fine, and medium roots; few very fine and fine pores; 10 to 20 percent gravel; common gypsum flakes; strongly calcareous; strongly alkaline (pH 8.8); clear, wavy boundary.
- C3—23 to 48 inches, light-gray (2.5Y 7/2) loam, light brownish gray (2.5Y 6/2) when moist; massive; hard, friable, slightly sticky and slightly plastic; few very fine and medium roots; few very fine, fine, and medium pores; few gypsum flakes; 2 to 5 percent gravel; strongly calcareous; strongly alkaline (pH 8.6); gradual, smooth boundary.
- C4—48 to 60 inches, pale-yellow (2.5Y 7/3) loam, light olive brown (2.5Y 5/3) when moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; few very fine pores; few gypsum flakes

and crystals; strongly calcareous; strongly alkaline (pH 8.6).

The soil is more than 60 inches deep. Between depths of 10 and 40 inches, it is typically loam, but it has stratifications of silt loam or very fine sandy loam. Few to common flakes or crystals of gypsum are between depths of 10 and 40 inches.

The A horizon is 6 to 8 inches thick. It is light yellowish brown or light brownish gray to light gray or pale yellow when dry and dark grayish brown to grayish brown, light olive brown, pale yellow, light yellowish brown, or light brownish gray when moist.

The C horizon is similar in color to the A horizon. Below a depth of 40 inches, the C horizon ranges from silty clay loam to very fine sandy loam. Gravel content is 0 to 20 percent.

RIB—Ravola loam, 1 to 2 percent slopes. This soil is on alluvial fans and alluvial plains. It has a profile similar to the one described as representative of the series, but it is only slightly eroded. Runoff is medium, and the hazard of erosion is slight.

Included with this soil in mapping are small areas of Billings silty clay loam; Mayfield shaly loam, 2 to 5 percent slopes; and Ravola loam, 2 to 5 percent slopes, eroded.

Most of the acreage of this soil is used for irrigated alfalfa, small grain, corn silage, and pasture. Some small areas are used as range. Capability units IIe-2 irrigated, VIIe-S nonirrigated; Semi-desert Loam range site.

RIC—Ravola loam, 2 to 5 percent slopes. This soil is on alluvial fans and alluvial plains. It has the profile described as representative of the series. Runoff is medium, and the hazard of erosion is moderate. Gravel content ranges from 0 to 20 percent below a depth of 20 inches.

Included with this soil in mapping are small areas of Mayfield shaly loam, 2 to 5 percent slopes; Billings silty clay loam; and Ravola loam, 2 to 5 percent slopes, eroded.

Most of the acreage of this soil is used for irrigated alfalfa, small grain, and irrigated pasture. Some small areas are used as range. Capability units IIIe-2 irrigated, VIIe-S nonirrigated; Semi-desert Loam range site.

RIC2—Ravola loam, 2 to 5 percent slopes, eroded. This soil is on alluvial fans and alluvial plains immediately below nearly barren Badland areas. It has a profile similar to the one described as representative of the series, but gypsum content is 8 to 30 percent and the surface layer is 4 to 8 inches thick. This soil is severely eroded. Sheet and rill erosion are moderate, and there are gullies 3 to 6 feet in depth and 300 to 1,800 feet apart. Runoff is medium, and the hazard of erosion is severe.

Differential settling of the soil, which occurs as the gypsum dissolves, results in an uneven surface layer and common small depressions and sinkholes. The color of the soil varies as the parent material varies and is red, brown, and olive. The color varies from place to place within a very short distance and also within the soil profile.

Included with this soil in mapping are small areas of Billings silty clay loam; Skumpah silt loam, 2 to 5 percent slopes, eroded; and Ravola loam, 2 to 5 percent slopes.

This soil is used as range and as habitat by upland game birds and small game. Differential settling when the soil is irrigated makes it unsuitable for cultivation and irrigation. It is also very unstable for engineering uses. Capability unit VIIe-S nonirrigated; Semi-desert Loam range site.

Rock Land

RO—Rock land is mainly outcrops of sandstone, shale, or limestone and stones or boulders dislodged from the outcrops. A thin mantle of soil covers the bedrock in places, but the stones and boulders almost obscure the soil characteristics. Most of this land type is moderately eroded, but some areas are severely eroded. The slopes are steep to perpendicular but typically are 40 to 80 percent.

Included in mapping are small areas of moderately steep to steep, shallow soils.

This land type has almost no value for range, although some areas have a sparse cover of grass, sagebrush, pinon, and juniper. Small areas are accessible to livestock and wildlife, but most of the land is too steep and rocky for grazing. Capability unit VIIIs-X nonirrigated; not assigned a range site.

Sanpete Series

The Sanpete series consists of somewhat excessively drained soils that formed in alluvium derived from limestone, sandstone, and shale on alluvial fans and alluvial plains. Sanpete soils are commonly associated with Arapien, Amtoft, Rapho, and Sigurd soils. Slope is 2 to 30 percent.

Elevation ranges from 5,100 to 6,600 feet. Above 6,200 feet the soils are on southern or western exposures. The average annual precipitation ranges from 8 to 13 inches, and the mean annual air temperature ranges from 45° to 49° F. The frost-free period is 115 to 130 days. Vegetation is big sagebrush, shadscale, and Indian ricegrass.

In a representative profile the surface layer is pale-brown and light-brown gravelly fine sandy loam and gravelly loam about 11 inches thick. The substratum is very pale brown and light-brown very gravelly sandy loam to a depth of about 48 inches and pink very gravelly sandy loam to a depth of 60 inches.

The Sanpete soils are very strongly calcareous, and reaction ranges from moderately alkaline to strongly alkaline. Permeability is rapid. The available water capacity is 2½ to 5 inches. The water-supplying capacity is 3 to 6 inches annually. The effective root zone is about 60 inches.

The Sanpete soils are used mainly as range, but some areas are used for irrigated crops of alfalfa, small grain, and pasture. The soils are also a source of road fill.

Representative profile of Sanpete gravelly fine sandy loam, 2 to 5 percent slopes, in a range area 3 miles south and 5 miles west of Gunnison, about 412 feet north and 660 feet east of the southwest corner of sec. 3, T. 20 S., R. 1 W., Sanpete County:

A11—0 to 3 inches, pale-brown (10YR 6/3) gravelly fine sandy loam, brown (10YR 4/3) when moist; weak, thin,

platy structure; soft, very friable, nonsticky and slightly plastic; few fine roots; common very fine pores; 30 percent gravel and cobbles; strongly calcareous; moderately alkaline (pH 8.4); abrupt, smooth boundary.

A12—3 to 11 inches, light-brown (7.5YR 6/3) gravelly light loam, brown (7.5YR 5/3) when moist; weak, medium, subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many fine roots; common very fine and few fine pores; 20 percent gravel and cobbles; strongly calcareous; moderately alkaline (pH 8.2); clear, wavy boundary.

C1ca—11 to 17 inches, very pale brown (10YR 7/3) very gravelly sandy loam, light brown (7.5YR 6/3) when moist; massive; soft, very friable, slightly sticky and slightly plastic; many fine roots; common very fine pores; 50 percent gravel and cobbles; very strongly calcareous, lime coatings on rock fragments and in soft rounded masses; moderately alkaline (pH 8.3); clear, wavy boundary.

C2ca—17 to 48 inches, light-brown (7.5YR 6/3) very gravelly sandy loam, brown (7.5YR 5/3) when moist; massive; soft, very friable, slightly sticky and slightly plastic; many fine roots; common very fine pores; 65 percent gravel and cobbles; very strongly calcareous, lime coatings on rock fragments and in soft rounded masses; moderately alkaline (pH 8.3); clear, wavy boundary.

C3—48 to 60 inches, pink (7.5YR 7/3) very gravelly sandy loam, brown (7.5YR 4/4) when moist; massive; soft, very friable, nonsticky and slightly plastic; few very fine roots; common very fine pores; 45 percent gravel and 10 percent cobbles; strongly calcareous; moderately alkaline (pH 8.4).

The soil is more than 60 inches deep. Between depths of 10 and 40 inches, it is typically very gravelly or very cobbly sandy loam but ranges to gravelly, very gravelly, cobbly, or very cobbly sandy loam to gravelly, very gravelly, cobbly, or very cobbly light sandy clay loam. Content of gravel and cobbles is 35 to 70 percent.

The A horizon is 7 to 15 inches thick. It is pale brown, light brown, pink, light brownish gray, light yellowish brown, or very pale brown when dry and brown or dark brown to dark grayish brown or grayish brown when moist. The A horizon is moderately calcareous to strongly calcareous.

The Cca horizon is 20 to 51 inches thick. It is very pale brown, light brown, light reddish brown, pink, pale brown, or light yellowish brown when dry and brown, light brown, reddish brown, light reddish brown, dark grayish brown, grayish brown, or pale brown when moist. The C horizon below a depth of 40 inches is similar in color and texture to the Cca horizon, but it is strongly calcareous.

SAc—Sanpete gravelly fine sandy loam, 2 to 5 percent slopes. This soil is on alluvial fans and alluvial plains. It has the profile described as representative of the series. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Sanpete cobbly fine sandy loam, 5 to 10 percent slopes, eroded, and Sigurd gravelly loam, 1 to 5 percent slopes. Also included are small areas near the end of alluvial fans that do not contain gravel in the surface layer.

This soil is used mainly as spring and fall range by sheep and cattle. It is also used for irrigated alfalfa, small grain, and pasture. This soil is a source of road fill. Capability units IVs-24 irrigated, VIIIs-S nonirrigated; Semi-desert Stony Loam range site.

SbD2—Sanpete cobbly fine sandy loam, 5 to 10 percent slopes, eroded. This soil is on alluvial fans and alluvial plains. It has a profile similar to the one described as representative of the series, but it is eroded and has gullies 2 to 12 feet deep and 500 to 1,300 feet

apart. Runoff is medium, and the hazard of erosion is severe.

Included with this soil in mapping are small areas of Sanpete gravelly fine sandy loam, 2 to 5 percent slopes; Sanpete stony fine sandy loam, 5 to 30 percent slopes; Sigurd cobbly fine sandy loam, 5 to 10 percent slopes, eroded; and Denmark gravelly loam, 2 to 5 percent slopes.

This soil is used as spring and fall range by sheep and cattle and is a good source of road fill. Capability unit VIIIs-S nonirrigated; Semi-desert Stony Loam range site.

SCE2—Sanpete stony fine sandy loam, 5 to 30 percent slopes, eroded. This soil is on alluvial fans and alluvial plains. It has a profile similar to the one described as representative of the series, but stones and cobbles cover 2 to 10 percent of the surface layer. Runoff is rapid, and the hazard of erosion is very severe. Sheet and rill erosion are active, and gullies 2 to 10 feet in depth are common. This soil contains variable quantities of gypsum in places, especially east of Axtell.

Included with this soil in mapping are small areas of Badland; Sanpete cobbly fine sandy loam, 5 to 10 percent slopes, eroded; Sanpete gravelly fine sandy loam, 2 to 5 percent slopes; and Denmark gravelly loam, 2 to 5 percent slopes.

This soil is used as spring and fall range by sheep and cattle. It is also a source of road fill. Capability unit VIIIs-S nonirrigated; Semi-desert Stony Loam range site.

Sanpitch Series

The Sanpitch series consists of well-drained soils that formed in alluvium or colluvium derived from limestone, shale, and mixed igneous rocks on foothills and alluvial fans. Sanpitch soils are most commonly associated with Atepic, Bagard, Borvant, and Obrast soils. Slope is 8 to 40 percent.

Elevation ranges from 5,700 to 7,000 feet. The average annual precipitation ranges from 12 to 14 inches, and the mean annual air temperature ranges from 43° to 45° F. The frost-free period is 90 to 110 days. Vegetation is dominantly juniper, pinon, perennial grasses, and big sagebrush.

In a representative profile the surface layer is grayish-brown very stony loam and gravelly loam about 7 inches thick. The substratum is pinkish-gray gravelly loam and gravelly clay loam to a depth of about 24 inches and is pinkish-gray and pinkish-white gravelly loam to a depth of 60 inches.

The Sanpitch soils are strongly calcareous. Permeability is moderate. The available water capacity is 7 to 9 inches. The water-supplying capacity is 8 to 9 inches annually. The effective root zone is 60 inches or more.

Sanpitch soils are used as spring and fall range by sheep and cattle and as winter range by deer and elk. They are also used for woodland of juniper and pinon.

Representative profile of Sanpitch very stony loam, 8 to 40 percent slopes, in a range area about 1 mile south of Birdseye on the east side of the highway,

about 330 feet south and 165 feet east of the northwest corner of sec. 1, T. 11 S., R. 3 E., Utah County:

A11—0 to 2 inches, grayish-brown (10YR 5/2) very stony loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; soft, friable, slightly sticky and slightly plastic; common fine roots; common fine pores; stones and cobbles cover 10 to 25 percent of the surface; moderately calcareous; moderately alkaline (pH 8.2); abrupt, smooth boundary.

A12—2 to 7 inches, grayish-brown (10YR 5/2) gravelly loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, subangular blocky structure; slightly hard, friable, sticky and plastic; common, medium, and fine roots; few fine pores; 25 percent gravel; strongly calcareous; moderately alkaline (pH 8.2); clear, smooth boundary.

C1ca—7 to 13 inches, pinkish-gray (7.5YR 7/2) gravelly loam, brown (7.5YR 5/3) when moist; weak, medium, subangular blocky structure; hard, friable, sticky and plastic; few coarse, medium, and fine roots; common fine pores; 20 percent gravel; very strongly calcareous, lime in veins and soft rounded masses; moderately alkaline (pH 8.4); clear, smooth boundary.

C2ca—13 to 20 inches, pinkish-gray (7.5YR 7/2) gravelly light clay loam, brown (7.5YR 5/3) when moist; weak, medium, subangular blocky structure; hard, friable, sticky and plastic; few fine and medium roots; common fine pores; 20 percent gravel; strongly calcareous, lime in soft rounded masses; strongly alkaline (pH 8.6); clear, smooth boundary.

C3ca—20 to 24 inches, pinkish-gray (7.5YR 7/2) gravelly loam, brown (7.5YR 5/3) when moist; massive; hard, friable, sticky and plastic; few fine and medium roots; few fine pores; 25 percent gravel; strongly calcareous, lime in veins; strongly alkaline (pH 8.6); abrupt, smooth boundary.

C4—24 to 37 inches, pinkish-gray (7.5YR 6/2) gravelly loam, brown (7.5YR 5/3) when moist; massive; hard, friable, sticky and plastic; common fine, few medium roots; few fine pores; 35 percent gravel; strongly calcareous; strongly alkaline (pH 8.6); abrupt, smooth boundary.

C5—37 to 42 inches, pinkish-white (7.5YR 8/2) gravelly loam, light brown (7.5YR 6/3) when moist; moderate, medium, platy structure; very hard, friable, slightly sticky and plastic; few fine and medium roots; few fine pores; 35 percent gravel; very strongly calcareous, lime in soft rounded masses; strongly alkaline (pH 8.6); clear, smooth boundary.

C6—42 to 60 inches, pinkish-white (7.5YR 8/2) gravelly loam, brown (7.5YR 5/3) when moist; massive; hard, friable, slightly sticky and slightly plastic; few fine roots; few fine pores; 20 percent gravel; strongly calcareous; strongly alkaline (pH 8.7).

The soil is 60 inches or more deep. Between depths of 10 and 40 inches it ranges from loam to gravelly loam or clay loam to gravelly clay loam. Content of gravel and cobbles ranges from 15 to 35 percent.

The A horizon is 7 to 16 inches thick. It is grayish brown, very dark grayish brown, or dark brown to brown when dry and very dark brown to dark brown or very dark grayish brown when moist. Reaction is neutral to moderately alkaline.

The Cca horizon is 9 to 25 inches thick. It is pinkish gray, light brown, or pale brown to pinkish white, white, or very pale brown when dry and brown, dark brown, or dark grayish brown to pink or very pale brown when moist. Reaction ranges from moderately alkaline to very strongly alkaline. Lime content ranges from 20 to 40 percent.

The lower part of the C horizon is similar to the Cca horizon, but gravel and cobble content is 20 to 50 percent below a depth of 40 inches.

SDE—Sanpitch very stony loam, 8 to 40 percent slopes. This soil is on foothills and alluvial fans. It has the profile described as representative of the series. Runoff is medium, and the hazard of erosion is moderate. In some places stones or cobbles cover less than

10 percent of the surface. Also in places the upper part of the substratum contains more than 40 percent lime.

Included with this soil in mapping are small areas of Bagard very stony clay loam, 10 to 40 percent slopes; Atepic shaly clay loam, 10 to 30 percent slopes, eroded; and Moroni silty clay, 2 to 8 percent slopes.

This soil is used as spring and fall range by sheep and cattle and as winter range by deer and elk. Juniper trees are harvested for cedar posts, and juniper and pinon are cut for firewood. Capability unit VIs-U non-irrigated; Upland Stony Loam (Juniper-Pinon) range site.

SEE—Sanpitch-Obrast complex, 8 to 40 percent slopes. This mapping unit is on foothills and alluvial fans. It is about 50 percent Sanpitch very stony loam, 8 to 40 percent slopes, on foothills and ridges; about 30 percent Obrast clay loam, low rainfall, 8 to 16 percent slopes, in swales and depressions; and about 10 percent each Ant Flat loam, low rainfall, 4 to 8 percent slopes, and Deer Creek stony silt loam, 6 to 30 percent slopes.

The Obrast soil commonly has an average annual precipitation of about 14 inches.

This mapping unit is used as spring and fall range by sheep or cattle and as winter range by deer and elk. On the Sanpitch soil juniper trees are harvested for cedar posts. Capability unit VIIs-U nonirrigated; Sanpitch soil in Upland Stony Loam (Juniper Pinon) range site, Obrast soil in Upland Clay range site.

Sanpitch Variant

The Sanpitch variant consists of well-drained soils that formed in alluvium derived from red shale and limestone on alluvial fans and foothills. These soils are associated with Atepic and Sanpitch soils. Slope is 10 to 30 percent.

Elevation ranges from 5,800 to 7,000 feet. The average annual precipitation ranges from 12 to 14 inches, and the mean annual air temperature ranges from 45° to 47° F. The frost-free period ranges from 90 to 110 days. Vegetation is dominantly juniper, pinon, grasses, and big sagebrush.

In a representative profile the surface layer is brown loam about 9 inches thick. The substratum is pink gravelly loam and gravelly sandy loam, to a depth of 19 inches. To a depth of 60 inches it is reddish-yellow, pink, and light reddish-brown loam and shaly silty clay loam.

These soils are moderately calcareous or strongly calcareous. Permeability is moderate. The effective root zone is 60 inches or more.

These soils are used as range.

Representative profile of Sanpitch loam, red variant, 10 to 30 percent slopes, 4 miles south of Birdseye, 1 mile east of the highway, and about 600 feet north of Dry Creek, about 1,500 feet west and 1,200 feet north of the southeast corner of sec. 7, T. 11 S., R. 4 E., Utah County:

A11—0 to 3 inches, brown (7.5YR 5/4) loam, dark brown (7.5YR 4/4) when moist; moderate, fine, granular structure; slightly hard, friable, sticky and plastic; few very fine roots; slightly calcareous; mildly alkaline (pH 7.6); clear, smooth boundary.

A12—3 to 9 inches, brown (7.5YR 5/4) heavy loam, dark brown (7.5YR 4/4) when moist; weak, medium, prismatic structure parting to moderate, medium, sub-angular blocky; slightly hard, friable, sticky and plastic; few fine and medium roots; few fine and medium pores; slightly calcareous; mildly alkaline (pH 7.6); clear, smooth boundary.

C1ca—9 to 14 inches, pink (7.5YR 7/4) gravelly loam, strong brown (7.5YR 5/6) when moist; massive; hard, friable, slightly sticky and slightly plastic; few fine and very fine roots; few fine pores; 20 percent gravel and lime hardpan fragments; strongly calcareous, lime in fine nodules; moderately alkaline (pH 8.4); abrupt, smooth boundary.

C2ca—14 to 19 inches, pink (7.5YR 7/4) gravelly sandy loam, yellowish red (5YR 5/6) when moist; massive; hard, friable, slightly sticky and slightly plastic; few fine and very fine roots; 25 percent gravel and hardpan fragments; very strongly calcareous, lime in fine rounded masses; moderately alkaline (pH 8.4); abrupt, smooth boundary.

C3—19 to 28 inches, reddish-yellow (5YR 6/6) loam, yellowish red (5YR 5/6) when moist; massive; hard, friable, slightly sticky and slightly plastic; root mat on surface of horizon, few fine roots in horizon; strongly calcareous, lime in veins; moderately alkaline (pH 8.4); gradual, smooth boundary.

C4—28 to 39 inches, pink (7.5YR 7/4) loam, yellowish red (5YR 5/6) when moist; massive; hard, friable, sticky and plastic; few very fine roots; 10 percent gravel and shale fragments; strongly calcareous, lime in veins and soft rounded masses; moderately alkaline (pH 8.4); gradual, smooth boundary.

C5—39 to 47 inches, light reddish-brown (5YR 6/4) loam, reddish brown (5YR 5/4) when moist; massive; 10 to 15 percent gravel and shale fragments; moderately calcareous, lime in veins; moderately alkaline (pH 8.4); gradual, smooth boundary.

C6—47 to 60 inches, reddish-yellow (5YR 5/6) shaly silty clay loam, yellowish red (5YR 5/6) when moist; massive; hard, firm, sticky and plastic; 40 percent gravel and shale fragments; strongly calcareous, lime coatings on rock fragments; moderately alkaline (pH 8.4).

The soil is 60 inches or more deep. It ranges from loam to gravelly loam or gravelly sandy loam between depths of 10 and 40 inches. Content of gravel is 0 to 30 percent.

The A horizon is 7 to 10 inches thick. It is brown to light brown when dry and dark brown to strong brown when moist. Reaction is slightly alkaline to moderately alkaline.

The Cca horizon is 10 to 20 inches thick. It is pink when dry and strong brown to yellowish red when moist. The Cca horizon is strongly calcareous to very strongly calcareous, and reaction is moderately alkaline to strongly alkaline.

The C horizon below the Cca horizon is pink to reddish yellow and light reddish brown. It ranges from loam to silty clay loam, and content of gravel and shale fragments is 10 to 40 percent.

SFD—Sanpitch loam, red variant, 10 to 30 percent slopes. This soil is on the alluvial fans and foothills. Runoff is medium, and the hazard of erosion is moderate. The available water capacity is 8 to 11 inches.

Included with this soil in mapping are small areas of Sanpitch very stony loam, 8 to 40 percent slopes; Atepic shaly clay loam, 10 to 30 percent slopes, eroded; and Badland.

This soil is used as spring and fall range by sheep, cattle, and deer. Capability unit VIs-U nonirrigated; Upland Stony Loam (Juniper-Pinon) range site.

Sedwell Series

The Sedwell series consists of well-drained soils that formed in alluvium and colluvium derived from lime-

stone and shale on mountainsides. Sedwell soils are commonly associated with Clegg, Lizzant, and Mower soils. Slope is 8 to 25 percent.

Elevation ranges from 6,800 to 7,800 feet. The average annual precipitation ranges from 14 to 20 inches, and the mean annual air temperature ranges from 43° to 45° F. The frost-free period is 90 to 110 days. Vegetation is mainly oakbrush, snowberry, maple, and grasses.

In a representative profile the surface layer is dark-brown and dark grayish-brown silt loam and silty clay loam about 22 inches thick. The substratum is grayish-brown cobbly silty clay loam about 25 inches thick. Shale bedrock is at a depth of 47 inches.

The Sedwell soils are very strongly calcareous, and reaction is neutral to strongly alkaline. Permeability is moderately slow. The available water capacity is 5 to 7 inches. The water-supplying capacity is 9 to 11 inches annually. The effective root zone is 40 to 60 inches.

Sedwell soils are used as summer range by sheep, cattle, and deer. They are mapped only with Lizzant soils.

Representative profile of Sedwell silt loam, 8 to 25 percent slopes, in a range area of Lizzant-Sedwell complex, 5 to 40 percent slopes, 4 miles east of Mount Pleasant near the junction of the power line and the jeep road, about 1,200 feet north and 2,500 feet east of the southwest corner of sec. 8, T. 15 S., R. 5 E., Sanpete County:

- A11—0 to 3 inches, dark-brown (10YR 3/3) silt loam, very dark brown (10YR 2/2) when moist; weak, thin, platy structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; few fine pores; slightly calcareous; neutral (pH 7.3); clear, smooth boundary.
- A12—3 to 13 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; weak, medium, subangular blocky structure; slightly hard, firm, sticky and plastic; few very fine and fine roots; few very fine and fine pores; strongly calcareous; mildly alkaline (pH 7.4); gradual, smooth boundary.
- A13—13 to 22 inches, dark grayish-brown (10YR 4/2) light silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, subangular blocky structure; hard, firm, sticky and plastic; few very fine and fine roots; few fine pores; 15 percent gravel and cobbles; strongly calcareous, lime in veins; mildly alkaline (pH 7.8); gradual, smooth boundary.
- C1ca—22 to 29 inches, grayish-brown (10YR 5/2) cobbly silty clay loam, dark brown (10YR 3/3) when moist; weak, fine, subangular blocky structure; hard, firm, sticky and plastic; few very fine and fine roots; few fine pores; 25 percent cobbles and gravel; strongly calcareous, lime in veins; mildly alkaline (pH 7.6); gradual, wavy boundary.
- C2ca—29 to 42 inches, grayish-brown (10YR 5/2) cobbly silty clay loam, dark grayish brown (10YR 4/2) when moist; massive; slightly hard, firm, sticky and plastic; few fine and medium roots; few fine pores; 30 percent cobbles; very strongly calcareous, lime in veins; moderately alkaline (pH 8.0); abrupt, wavy boundary.
- C3ca—42 to 47 inches, white (10YR 8/2) very shaly silt loam, pale yellow (2.5Y 7/3) when moist; moderate, medium, platy structure; hard, firm, sticky and plastic; few very fine roots matted along shale plates; 70 percent soft weathering shale; very strongly calcareous; mildly alkaline (pH 7.8); gradual, wavy boundary.
- C4—47 inches, shale bedrock.

Depth to shale is 40 to 60 inches. It is cobbly silt loam or cobbly silty clay loam between depths of 10 and 40 inches.

The A horizon is 20 to 30 inches thick. It is dark brown, dark grayish brown, very dark grayish brown, grayish brown, or brown when dry and very dark brown, very dark grayish brown, or dark brown when moist. The A horizon is slightly calcareous to strongly calcareous, and reaction is neutral to mildly alkaline.

The Cca horizon is grayish brown, brown, pale brown, light brownish gray, very pale brown, light gray, or white when dry and dark brown, very dark grayish brown, dark grayish brown, brown, or grayish brown when moist. Reaction ranges from mildly alkaline to strongly alkaline.

Shaly Colluvial Land

SH—Shaly colluvial land is a mixture of soil material, cobbles, stones, and rock fragments. It has accumulated on steep and very steep sides of benches and mesas and at the bases of slopes, mainly as the result of gravity. This colluvium varies in thickness, and in some places it is as much as 3 feet thick over shale. The benches or mesas are capped with gravelly or cobbly soils. As the shale on the slopes of the benches and mesas erodes away, this capping falls and rolls down the slope. From 20 to 40 percent of the surface is shale outcrops. Because of the steep slopes, the lack of precipitation to establish plants, and the unconsolidated nature of the colluvium, active erosion is moderate to severe. This land type is a high producer of silt as a result of runoff from summer storms or rapid snow-melt.

Included in mapping are small areas of Badland, Rock outcrop, and a deep, stony loam soil.

The dominant vegetation is shadscale, greasewood, Indian ricegrass, and horsebrush. This land is used as spring and fall range by sheep and cattle. Capability unit VIIIs-S nonirrigated; Semi-desert Shallow Loam range site.

Shumway Series

The Shumway series consists of poorly drained soils that formed in alluvium derived from limestone and shale on valley bottoms. Shumway soils are commonly associated with Anco, Ephraim, Kjar, and Poganeab soils. Slope is 0 to 2 percent.

Elevation ranges from 5,100 to 5,700 feet. The average annual precipitation ranges from 9 to 12 inches, and the mean annual air temperature ranges from 45° to 52° F. The frost-free period is 110 to 130 days. Vegetation is wiregrass, sedges, saltgrass, and rubber rabbitbrush.

In a representative profile the surface layer is light brownish-gray silty clay loam about 3 inches thick. The subsoil is light-gray silty clay about 22 inches thick. The substratum to a depth of 60 inches is light-gray and gray silty clay and clay.

The Shumway soils are very strongly calcareous. Permeability is slow. The available water capacity is 8 to 12 inches. The effective root zone is about 60 inches. The seasonal high water table is at a depth of 10 to 60 inches or more.

Shumway soils are used for native grass pasture and, where drained, for irrigated alfalfa, small grain, and pasture.

Representative profile of Shumway silty clay loam, in a native pasture 2 miles north of Manti, about 990

feet east and 900 feet north of the southwest corner of sec. 30, T. 17 S., R. 3 E., Sanpete County:

- A11—0 to 3 inches, light brownish-gray (10YR 6/2) silty clay loam, dark grayish brown (10YR 4/2) when moist; massive; soft, friable, sticky and plastic; many fine and very fine roots; very strongly calcareous; strongly alkaline (pH 9.0); abrupt, smooth boundary.
- A12—3 to 13 inches, light-gray (5Y 6/1) silty clay, dark gray (5Y 4/1) when moist; moderate, medium, angular blocky structure; very hard, very firm, very sticky and very plastic; many fine and very fine roots; few fine pores; strongly calcareous; very strongly alkaline (pH 9.2); clear, smooth boundary.
- B2—13 to 25 inches, light-gray (5Y 7/1) silty clay, gray (5Y 5/1) when moist; massive; very hard, very firm, very sticky and very plastic; few fine and very fine roots; few very fine pores; very strongly calcareous; very strongly alkaline (pH 9.2); clear, smooth boundary.
- C1g—25 to 36 inches, light-gray (2.5Y 7/1) silty clay, gray (2.5Y 5/1) when moist; massive; very hard, extremely firm, very sticky and very plastic; few fine and very fine roots; very strongly calcareous; very strongly alkaline (pH 9.2); abrupt, smooth boundary.
- A1bg—36 to 40 inches, gray (2.5Y 5/1) silty clay, very dark gray (2.5Y 3/1) when moist; massive; extremely hard, very firm, very sticky and very plastic; few very fine roots; very strongly calcareous; very strongly alkaline (pH 9.2); clear, smooth boundary.
- C2bg—40 to 60 inches, light-gray (2.5Y 7/1) clay, gray (2.5Y 5/1) when moist; massive; extremely hard, extremely firm, very sticky and very plastic; few fine roots; very strongly calcareous; very strongly alkaline (pH 9.2).

The soil is more than 60 inches deep. There are either chroma of 1 or mottles at a depth of less than 20 inches. Between depths of 10 and 40 inches the soil is typically silty clay but ranges from heavy silty clay loam to clay. When dry the soil cracks, and cracks are 20 inches or more in depth and at least $\frac{1}{8}$ inch in width.

The A horizon is 7 to 17 inches thick. It is light brownish gray, light gray, gray, or grayish brown when dry and dark grayish brown, dark gray, gray, or grayish brown when moist. Reaction ranges from moderately alkaline to very strongly alkaline.

The B2 horizon and C horizon are light gray, gray, grayish brown, or light brownish gray when dry and gray, dark gray, dark grayish brown, grayish brown, or light brownish gray when moist. Reaction in the B horizon and C horizon is moderately alkaline to very strongly alkaline.

Sm—Shumway silty clay loam. This soil is on valley bottoms in fairly large areas. Slope is 0 to 2 percent. This soil has the profile described as representative of the series. Runoff is slow, and the hazard of erosion is slight.

Included with this soil in mapping are small areas of Abcal silty clay loam; Kjar peaty silty loam; and Poganeab silt loam.

This soil is used for native grass pasture and native grass hay. It is also used as a nesting area by upland game birds. Capability unit Vw-2 nonirrigated; Wet Meadows range site.

Sn—Shumway silty clay loam, drained. This soil is on the lower parts of alluvial fans. It is at slightly higher elevations than Shumway silty clay loam and has been drained. Slope is 0 to 2 percent. The depth to the water table ranges from 40 to 60 inches or more. Runoff is slow, and the hazard of erosion is slight.

Included with this soil in mapping are small areas of Shumway silty clay loam; Ephraim silty clay loam; and Abcal silty clay loam.

This soil is used for irrigated alfalfa, small grain,

and pasture. Capability unit IIIw-2 irrigated; range site not assigned.

Sigurd Series

The Sigurd series consists of somewhat excessively drained soils that formed in alluvium derived from limestone, sandstone, and minor amounts of shale on alluvial fans and flood plains. Sigurd soils are commonly associated with Genola, Linoyer, and Sanpete soils. Slopes are typically smooth and are 1 to 10 percent.

Elevation ranges from 5,000 to 6,200 feet. The average annual precipitation ranges from 8 to 12 inches, and the mean annual air temperature ranges from 45° to 49°F. The frost-free period is 110 to 130 days. Vegetation of the noncultivated areas is dominantly big sagebrush, shadscale, yellowbrush, and Indian ricegrass.

In a representative profile the surface layer is pale-brown gravelly loam about 4 inches thick. The substratum to a depth of 60 inches is very pale brown, pale-brown, and light yellowish-brown very gravelly loam and gravelly and very gravelly fine sandy loam.

The Sigurd soils are strongly calcareous in the surface layer and very strongly calcareous below the surface layer. Reaction is moderately alkaline to very strongly alkaline. Permeability is rapid. The available water capacity is 3 to 5 inches. The water-supplying capacity of nonirrigated soils is 4 to 6 inches annually. The effective root zone is about 60 inches.

Sigurd soils are used for irrigated alfalfa, small grain, and improved pasture. They are also used as range, as habitat for upland game birds, and as a source of road fill.

Representative profile of Sigurd gravelly loam, 1 to 5 percent slopes, in a range area 3 miles west and $\frac{1}{2}$ mile south of Gunnison, about 2,395 feet north and 1,030 feet east of the southwest corner of sec. 22, T. 19 S., R. 1 W., Sanpete County:

- A1—0 to 4 inches, pale-brown (10YR 6/3) gravelly light loam, yellowish brown (10YR 5/4) when moist; weak, thick, platy structure; soft, friable, slightly sticky and slightly plastic; few very fine, fine, and medium roots; common very fine and fine vesicular pores; 35 percent gravel; strongly calcareous; moderately alkaline (pH 8.4); clear, smooth boundary.
- C1—4 to 9 inches, very pale brown (10YR 7/3) very gravelly loam, pale brown (10YR 6/3) when moist; massive; loose, friable, slightly sticky and slightly plastic; few very fine, fine, and medium roots; 70 percent gravel; very strongly calcareous; moderately alkaline (pH 8.4); clear, smooth boundary.
- C2—9 to 25 inches, pale-brown (10YR 6/3) very gravelly fine sandy loam, yellowish brown (10YR 5/4) when moist; massive; loose, friable, slightly sticky and slightly plastic; few very fine and fine roots; few very fine pores; 65 percent gravel; few interstices not filled with soil fines; very strongly calcareous; strongly alkaline (pH 8.6); clear, smooth boundary.
- C3—25 to 43 inches, light yellowish-brown (10YR 6/4) gravelly fine sandy loam, yellowish brown (10YR 5/4) when moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine and very fine roots; few very fine pores; 40 percent gravel; very strongly calcareous; moderately alkaline (pH 8.2); clear, wavy boundary.
- C4—43 to 60 inches, pale-brown (10YR 6/3) very gravelly fine sandy loam, yellowish brown (10YR 5/4) when

moist; massive; loose, friable, slightly sticky and slightly plastic; 55 percent gravel; very strongly calcareous; moderately alkaline (pH 8.3).

The soil is more than 60 inches deep. Texture between depths of 10 and 40 inches ranges from gravelly or very gravelly loam or gravelly or very gravelly sandy loam to cobbly or very cobbly loam or sandy loam. Rock fragments are mainly gravel and cobbles, and content is 35 to 70 percent.

The A horizon is 4 to 10 inches thick. It is pale brown, very pale brown, or light brown to pink when dry and yellowish brown, dark brown, grayish brown, or brown when moist. The A horizon ranges from gravelly fine sandy loam to gravelly light loam. Gravel content is 15 to 35 percent.

The C horizon is very pale brown, pale brown, light brown, or light yellowish brown to pink when dry and pale brown, yellowish brown, or dark brown to light brown when moist.

SoD2—Sigurd cobbly fine sandy loam, 5 to 10 percent slopes, eroded. This soil is on alluvial fans. It has a profile similar to the one described as representative of the series, but the rock fragments are mainly cobbles, especially on the surface. The soil is moderately eroded. Runoff is medium, and the hazard of erosion is severe. There are deep gullies 200 to 500 feet apart; sheet and rill erosion are common.

Included with this soil in mapping are small areas of Sigurd gravelly loam, 1 to 5 percent slopes, and Sanpete cobbly fine sandy loam, 5 to 10 percent slopes, eroded.

This soil is used as range. Capability unit VII_s-S nonirrigated; Semi-desert Stony Loam range site.

SpC—Sigurd gravelly loam, 1 to 5 percent slopes. This soil is on alluvial fans and flood plains. It has the profile described as representative of the series. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Rapho gravelly fine sandy loam, 2 to 5 percent slopes; Linoyer very fine sandy loam, 2 to 5 percent slopes, eroded; and Sanpete gravelly fine sandy loam, 2 to 5 percent slopes.

This soil is used mainly for irrigated alfalfa, small grain, and pasture. It is also used as range and as a source of road fill. Capability units IV_s-24 irrigated, VII_s-S nonirrigated; Semi-desert Stony Loam range site.

Skumpah Series

The Skumpah series consists of well-drained soils that formed in alluvium derived mainly from shale, on alluvial fans, alluvial plains, and valley bottoms. Skumpah soils are commonly associated with Badland, Billings, Mayfield, and Ravola soils. Slope is 1 to 5 percent.

Elevation ranges from 5,000 to 5,600 feet. The average annual precipitation ranges from 8 to 10 inches, and the mean annual air temperature ranges from 45° to 49° F. The frost-free period is 115 to 130 days. Vegetation is shadscale, greasewood, and yellowbrush.

In a representative profile (fig. 11) the surface layer is very pale brown silt loam about 3 inches thick. The subsoil is light-brown silty clay loam about 10 inches thick. The substratum to a depth of about 60 inches

is light-brown and pinkish-gray silt loam that has threads and veins of gypsum.

The Skumpah soils are strongly calcareous and are strongly saline-alkali. Permeability is moderately slow. The available water capacity is 1 to 2½ inches. The high content of salt reduces the amount of water available to plants. The water-supplying capacity is less than 4 inches annually. The effective root growth of most plants is restricted by the high content of salt at depths below 12 inches.

Skumpah soils are used mainly as range. A few small areas have been cleared of brush and are being cultivated. The soils are very unstable for construction uses. They develop sinkholes and are subject to differential settling. Gypsum is dissolved and removed by irrigation. These soils are only in the area between Axtell and Mayfield from the Sevier County line on the south to the Gunnison-Mayfield Highway on the north.

Representative profile of Skumpah silt loam, 1 to 2 percent slopes, in a range area 2 miles south of the Axtell Post Office by the Redmond Airport fence, about 1,800 feet north and 660 feet east of the southwest corner of sec. 29, T. 20 S., R. 1 E., Sanpete County:

- A21—0 to 1 inch, very pale brown (10YR 7/3) silt loam, brown (10YR 5/3) when moist; weak, thick, platy structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; many fine and very fine vesicular pores; strongly calcareous; strongly alkaline (pH 8.6); abrupt, smooth boundary.
- A22—1 to 3 inches, very pale brown (10YR 7/3) silt loam, brown (10YR 5/3) when moist; weak, medium, platy structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; many fine and very fine vesicular pores; strongly calcareous; strongly alkaline (pH 8.6); abrupt, smooth boundary.
- B21t—3 to 7 inches, light-brown (7.5YR 6/3) silty clay loam, brown (7.5YR 4/3) when moist; weak, medium, prismatic structure parting to strong, fine and very fine angular blocky; hard, firm, sticky and plastic; few very fine and fine roots; few very fine pores; continuous, thin clay films; strongly calcareous; moderately alkaline (pH 8.4); clear, smooth boundary.
- B22t—7 to 13 inches, light-brown (7.5YR 6/3) silty clay loam, brown (7.5YR 4/3) when moist; weak, coarse, prismatic structure parting to moderate, medium, sub-angular blocky; hard, firm, sticky and plastic; few very fine and fine roots; few very fine pores; few thin clay films; strongly calcareous; moderately alkaline (pH 8.4); abrupt, smooth boundary.
- C1cs—13 to 27 inches, light-brown (7.5YR 6/3) silt loam, dark brown (7.5YR 4/3) when moist; massive; hard, friable, slightly sticky and plastic; few very fine pores; many fine veins and flakes of gypsum; strongly calcareous; moderately alkaline (pH 8.4); abrupt, smooth boundary.
- C2cs—27 to 39 inches, pinkish-gray (7.5YR 7/2) silt loam, dark brown (7.5YR 4/3) when moist; weak, medium and thick, platy structure; slightly hard, friable, slightly sticky and plastic; few very fine roots; common very fine pores; common veins and flakes of gypsum; strongly calcareous; moderately alkaline (pH 8.6); gradual, wavy boundary.
- C3—39 to 45 inches, light-brown (7.5YR 6/3) silt loam, brown (7.5YR 4/3) when moist; massive; soft, very friable, slightly sticky and slightly plastic; few very fine roots; common very fine pores; few veins and threads of gypsum; strongly calcareous; moderately alkaline (pH 8.2); abrupt, smooth boundary.
- C4cs—45 to 60 inches, light-brown (7.5YR 6/3) silt loam, brown (7.5YR 4/3) when moist; massive; slightly hard, friable, slightly sticky and plastic; few very fine roots; few very fine pores; common veins and threads of gypsum; strongly calcareous; moderately alkaline (pH 8.0).



Figure 11.—Typical landscape of Skumpah silt loam, 1 to 2 percent slopes. Vegetation is mainly shadscale.

The soil is 60 inches or more deep.

The A2 horizon is 1½ to 5 inches thick. It is very pale brown, light brown, pink, or pinkish gray to grayish brown or light brownish gray when dry and brown, dark brown, dark grayish brown, or grayish brown when moist. Reaction ranges from moderately alkaline to strongly alkaline. The A2 horizon is silty clay loam to clay loam.

The B2t horizon is 6 to 12 inches thick. It is moderately saline to strongly saline, and reaction ranges from strongly alkaline to very strongly alkaline. Clay films are thin and are few to continuous.

The C horizon has the same range of color as the A2 horizon. It is typically silt loam or very fine sandy loam but ranges to silty clay loam. The C horizon ranges from strongly saline to very strongly saline, and reaction is mildly alkaline to moderately alkaline. Content of gypsum ranges from 1 to more than 10 percent.

SrB—Skumpah silt loam, 1 to 2 percent slopes. This soil is usually in long narrow areas on alluvial fans, alluvial plains, and valley bottoms. It has the profile described as representative of the series. Runoff is medium, and the hazard of erosion is severe. Soil blowing is severe and has removed the surface layer in places.

Included with this soil in mapping are small areas of Skumpah silt loam, 2 to 5 percent slopes, eroded; Ravola loam, 2 to 5 percent slopes, eroded; and Badland.

This soil is used as spring and fall range by sheep

and cattle. A limited acreage is cultivated. Capability unit VIIIs-S8 nonirrigated; Semi-desert Alkali Flats range site.

SrC2—Skumpah silt loam, 2 to 5 percent slopes, eroded. This soil is usually in long narrow areas on alluvial fans. It has a profile similar to the one described as representative of the series, but it is eroded, and there are gullies 3 to 15 feet in depth and 300 to 1,300 feet apart. Runoff is rapid, and the hazard of erosion is very severe. In places soil blowing has removed the surface layer.

Included with this soil in mapping are small areas of Skumpah silt loam, 1 to 2 percent slopes; Ravola loam, 2 to 5 percent slopes, eroded; and Badland.

This soil is used as spring and fall range by sheep and cattle. Capability unit VIIIs-S8 nonirrigated; Semi-desert Alkali Flats range site.

Skylick Series

The Skylick series consists of well-drained soils that formed in colluvium derived from sandstone on mountainsides. Skylick soils are commonly associated with Gothic, Mortenson, Pritchett, and Tingey soils. Slope is 4 to 70 percent.

Elevation ranges from 7,400 to 9,500 feet. The average annual precipitation ranges from 25 to 30 inches, and the mean annual air temperature ranges from 38° to 42° F. The frost-free period is 75 to 90 days. Vegetation is aspen, maple, western coneflower, and perennial grasses.

In a representative profile the surface layer is very dark grayish-brown silt loam about 27 inches thick. The subsoil is brown clay loam and cobbly clay loam to a depth of 66 inches.

Reaction is slightly acid to mildly alkaline. Permeability is slow. The available water capacity is 8 to 12 inches. The water-supplying capacity is 16 to 24 inches annually. The effective root zone is about 60 inches.

Skylick soils are used as summer range by sheep, cattle, deer, and elk. They are also used as aspen woodland.

Representative profile of Skylick silt loam, 4 to 30 percent slopes, in a range area $\frac{1}{4}$ mile above Buckhorn Flat in North Canyon, 700 feet east and 900 feet north of the southwest corner of sec. 34, T. 14 S., R. 5 E., Sanpete County:

A11—0 to 5 inches, very dark grayish-brown (10YR 3/2) silt loam, very dark brown (10YR 2/2) when moist; moderate, fine, granular structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; few fine and very fine pores; slightly acid (pH 6.4); clear, smooth boundary.

A12—5 to 17 inches, very dark grayish-brown (10YR 3/2) silt loam, very dark brown (10YR 2/2) when moist; weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few coarse, medium, fine, and very fine roots; few fine and very fine pores; slightly acid (pH 6.4); gradual, smooth boundary.

A13—17 to 27 inches, very dark grayish-brown (10YR 3/2) heavy silt loam, very dark brown (10YR 2/2) when moist; weak, medium, subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few coarse, medium, fine, and very fine roots; few fine and very fine pores; slightly acid (pH 6.4); gradual, smooth boundary.

B21t—27 to 42 inches, brown (7.5YR 5/4) clay loam, dark brown (7.5YR 4/3) when moist; weak, medium, prismatic structure parting to strong, medium, angular blocky; very hard, firm, sticky and plastic; few fine roots; common very fine pores; common moderately thick clay films; slightly acid (pH 6.4); gradual, smooth boundary.

B22t—42 to 52 inches, brown (7.5YR 5/4) cobbly clay loam, dark brown (7.5YR 4/3) when moist; weak, medium, prismatic structure parting to moderate, medium, angular blocky; very hard, firm, sticky and plastic; few fine roots; common very fine pores; common moderately thick clay films; 25 percent cobbles; slightly acid (pH 6.4); gradual, smooth boundary.

B23t—52 to 66 inches, brown (7.5YR 5/4) cobbly clay loam, dark brown (7.5YR 4/4) when moist; moderate, medium, subangular blocky structure; few fine and very fine roots; few fine pores; common moderately thick clay films; 20 percent cobbles and 10 percent gravel; slightly acid (pH 6.4); gradual, wavy boundary.

The soil is more than 60 inches deep.

The A horizon is 21 to 34 inches thick. It is very dark grayish brown, dark grayish brown, or dark brown when dry and very dark brown, very dark grayish brown, or dark brown when moist. The A horizon is silty loam to silty clay loam.

The B2t horizon is grayish brown, brown, or yellowish brown to light brownish gray, pale brown, or light yellowish brown when dry and very dark grayish brown or dark brown when moist. It is clay loam, heavy sandy clay loam, or cobbly clay loam. Content of cobbles and gravel ranges from 10 to 35 percent.

The C horizon, when present, is light yellowish brown, grayish brown, light grayish brown, brown, or light brown when dry and brown, dark brown, grayish brown, or dark grayish brown when moist. It ranges from clay loam to clay.

SSD—Skylick silt loam, 4 to 30 percent slopes. This soil is on mountainsides. It has the profile described as representative of the series. Runoff is medium, and the hazard of erosion is slight.

Included with this soil in mapping are small areas of Mortenson silt loam, 40 to 70 percent slopes; Gothic stony loam, 25 to 40 percent slopes; and a similar soil that has a surface layer less than 20 inches thick.

This soil is used as summer range by sheep, cattle, deer, and elk. It is used as aspen woodland and as a water catchment area for watersheds. The soil also provides excellent sites for summer homes and picnics.

This soil has a site index of 67 for aspen. The average annual production is about 20 cubic feet of cordwood or 52 board feet of sawtimber per acre. Seedling mortality is moderate; windthrow hazard and plant competition are slight; equipment restriction is moderate to severe. Capability unit VIe-H nonirrigated; High Mountain Loam (Aspen) range site.

SSF—Skylick silt loam, 30 to 70 percent slopes. This soil is in large areas on mountainsides. It is on northern exposures at the lower elevations but is on all exposures at higher elevations. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Mortenson silt loam, 40 to 70 percent slopes; Gothic stony loam, 25 to 40 percent slopes; and a similar soil that has a surface layer less than 20 inches thick.

This soil is used as summer range by sheep, cattle, deer, and elk. It is also used as aspen woodland and as a water catchment area for watersheds.

This soil has a site index of 67 for aspen. The average annual production is about 20 cubic feet of cordwood or 52 board feet of sawtimber per acre. Seedling mortality is moderate; windthrow hazard and plant competition are slight; and equipment restriction is moderate to severe. Capability unit VIIe-H nonirrigated; High Mountain Loam (Aspen) range site.

Snake Hollow Series

The Snake Hollow series consists of well-drained soils that formed in alluvium derived from quartzite conglomerate and sandstone on alluvial fans and alluvial plains. Snake Hollow soils are commonly associated with Calita, Collard, and Doyce soils. Slope is 2 to 4 percent.

Elevation ranges from 5,600 to 6,000 feet. The average annual precipitation ranges from 12 to 14 inches, and the mean annual air temperature ranges from 45° to 48° F. The frost-free period is 100 to 110 days. Vegetation is dominantly big sagebrush, annual and perennial grasses, and rabbitbrush.

In a representative profile the surface layer is brown gravelly fine sandy loam and gravelly sandy loam about 16 inches thick. The subsoil is brown gravelly sandy loam about 9 inches thick. The substratum to a depth of about 60 inches is brown gravelly sandy loam, fine sandy loam, and very gravelly sandy loam.

Reaction is neutral to mildly alkaline. Permeability is moderately rapid. The available water capacity is 4 to 6 inches. The water-supplying capacity is 6 to 8 inches annually. The effective root zone is about 60 inches.

Snake Hollow soils are used for irrigated and non-irrigated alfalfa and grass. They are also used as range and as a source of road fill.

Representative profile of Snake Hollow gravelly fine sandy loam, 2 to 4 percent slopes, in an abandoned cultivated field about 1 mile east of Jerusalem and 400 feet west of the highway, about 825 feet south and 400 feet west of the northeast corner of sec. 36, T. 14 S., R. 2 E., Sanpete County:

- A11—0 to 3 inches, brown (7.5YR 5/3) gravelly fine sandy loam, dark brown (7.5YR 3/3) when moist; moderate, medium, granular structure; slightly hard, very friable, nonsticky and slightly plastic; common very fine roots; few fine pores; 20 percent gravel, some a surface mantle; neutral (pH 6.8); abrupt, smooth boundary.
- A12—3 to 8 inches, brown (7.5YR 5/3) gravelly fine sandy loam, dark brown (7.5YR 3/3) when moist; weak, fine, subangular blocky structure; slightly hard, very friable, nonsticky and slightly plastic; common very fine roots; few very fine and medium pores; 20 percent gravel; neutral (pH 6.8); clear, smooth boundary.
- A13—8 to 16 inches, brown (7.5YR 5/3) gravelly sandy loam, dark brown (7.5YR 3/3) when moist; weak, medium, subangular blocky structure; slightly hard, very friable, nonsticky and slightly plastic; few very fine roots; few fine pores; 40 percent gravel; neutral (pH 7.0); clear, smooth boundary.
- B2—16 to 25 inches, brown (7.5YR 5/3) gravelly heavy sandy loam, dark brown (7.5YR 3/3) when moist; moderate, medium, subangular blocky structure; hard, friable, nonsticky and slightly plastic; few very fine roots; few very fine and common fine pores; 25 percent gravel; neutral (pH 7.2); gradual, wavy boundary.
- C1—25 to 33 inches, brown (7.5YR 5/3) gravelly fine sandy loam, dark brown (7.5YR 3/3) when moist; massive; hard, friable, nonsticky and slightly plastic; few very fine roots; few very fine pores; 35 percent gravel; slightly calcareous, lime in veins and segregated on gravel; mildly alkaline (pH 7.6); gradual, wavy boundary.
- C2—33 to 46 inches, brown (7.5YR 5/3) gravelly sandy loam, dark brown (7.5YR 3/3) when moist; massive; hard, very friable, nonsticky and slightly plastic; few very fine roots; few fine pores; 25 percent gravel; slightly calcareous, lime in veins and segregated on gravel; mildly alkaline (pH 7.7); gradual, wavy boundary.
- C3—46 to 53 inches, brown (7.5YR 5/3) gravelly fine sandy loam, dark brown (7.5YR 3/3) when moist; massive; slightly hard, friable, nonsticky and slightly plastic; few fine roots; few fine pores; 20 percent gravel; slightly calcareous, lime in veins and segregated on gravel; mildly alkaline (pH 7.6); gradual, wavy boundary.
- C4—53 to 60 inches, brown (7.5YR 5/4) very gravelly sandy loam, dark brown (7.5YR 3/4) when moist; massive; soft, very friable, nonsticky and slightly plastic; few very fine roots; 60 to 70 percent gravel; slightly calcareous, lime in veins and segregated on gravel; neutral (pH 7.0).

The soil is more than 60 inches deep. Texture between depths of 10 and 40 inches ranges from gravelly fine sandy loam to gravelly sandy loam. Content of gravel averages 20 to 30 percent.

The A horizon is 8 to 13 inches thick. It is brown, dark brown, dark grayish brown, or grayish brown when dry and dark brown, very dark brown, or very dark grayish brown when moist.

The B2 horizon and C horizon are brown, light brown, grayish brown, pale brown, or light brownish gray when dry

and dark brown, brown, dark grayish brown, or grayish brown when moist.

The C horizon is noncalcareous to slightly calcareous. The C horizon ranges from gravelly or very gravelly fine sandy loam to gravelly or very gravelly loamy sand below a depth of 40 inches. Content of gravel ranges from 20 to 60 percent.

StB—Snake Hollow gravelly fine sandy loam, 2 to 4 percent slopes. This soil is on alluvial fans and alluvial plains. It is in medium-sized areas. Runoff is medium, and the hazard of erosion is slight.

Included with this soil in mapping are small areas of Collard gravelly sandy loam, 4 to 8 percent slopes; Birdow very fine sandy loam, 2 to 4 percent slopes; and a few areas of Snake Hollow gravelly fine sandy loam that has slopes of 4 to 8 percent.

This soil is used for irrigated and nonirrigated alfalfa and grass and for irrigated small grain. It is also used as range and as a source of road fill. Capability units I1e-2 irrigated; VIe-U nonirrigated; Upland Loam range site.

Tingey Series

The Tingey series consists of well-drained soils that formed in alluvium and colluvium derived from sandstone and limestone on mountainsides. Tingey soils are commonly associated with Deer Creek, Mortenson, Pritchett, and Skylick soils. Slope is 40 to 80 percent.

Elevation ranges from 7,200 to 8,400 feet. The average annual precipitation ranges from 20 to 25 inches, and the mean annual air temperature ranges from 43° to 45° F. The frost-free period is 80 to 90 days. Vegetation is dominantly oakbrush, snowberry, and perennial grasses.

In a representative profile the surface layer is dark-brown stony silt loam and silt loam about 9 inches thick. The subsoil is brown, yellowish-brown, and light yellowish-brown sandy clay loam, stony clay loam, and stony sandy clay loam about 32 inches thick. The substratum to a depth of about 60 inches is light yellowish-brown stony and very stony loam.

Permeability is moderately slow. The available water capacity is 6 to 8 inches. The water-supplying capacity is 12 to 15 inches annually. The effective root zone is about 60 inches. The substratum is slightly calcareous to moderately calcareous.

Tingey soils are used as summer range by sheep, cattle, deer, and elk and winter range by deer and elk.

Representative profile of Tingey stony silt loam, in an area of Tingey-Rock outcrop complex, 40 to 70 percent slopes, in a range area 2 miles east of the lower power plant in Pleasant Creek Canyon, about 500 feet north of the creek, about 1,485 feet south and 1,320 feet east of the northwest corner of sec. 10, T. 15 S., R. 5 E., Sanpete County:

- A11—0 to 4 inches, dark-brown (10YR 4/3) stony silt loam, dark brown (10YR 3/3) when moist; moderate, fine, granular structure; slightly hard, friable, slightly plastic; common fine and few very fine roots; few fine and medium pores; stones cover 5 to 10 percent of the surface; slightly acid (pH 6.4); clear, smooth boundary.
- A12—4 to 9 inches, dark-brown (10YR 4/3) silt loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, granular structure; slightly hard, friable, slightly sticky and slightly plastic; few medium,

fine, and very fine roots; few fine pores; slightly acid (pH 6.4); gradual, smooth boundary.

B1—9 to 14 inches, brown (10YR 5/3) sandy clay loam, dark brown (10YR 3/3) when moist; moderate, fine, subangular blocky structure; hard, firm, slightly sticky and plastic; common fine and few medium roots; few fine and medium pores; neutral (pH 6.6); gradual, smooth boundary.

B21t—14 to 20 inches, yellowish-brown (10YR 5/4) stony clay loam, dark brown (10YR 4/3) when moist; moderate, medium, subangular blocky structure; very hard, firm, sticky and plastic; few fine and very fine roots; few fine and medium pores; common thin clay films; 20 percent rock fragments, dominantly stones; neutral (pH 6.8); gradual, smooth boundary.

B22t—20 to 28 inches, light yellowish-brown (10YR 6/4) stony clay loam, dark yellowish brown (10YR 4/4) when moist; strong, medium, subangular blocky structure; very hard, very firm, sticky and plastic; few medium, fine, and very fine roots; few coarse, medium, and fine pores; common thin clay films; 25 percent rock fragments, dominantly stones; neutral (pH 7.2); clear, wavy boundary.

B8ca—28 to 41 inches, light yellowish-brown (10YR 6/4) stony sandy clay loam, dark yellowish brown (10YR 4/4) when moist; moderate, medium, subangular blocky structure; hard, firm, sticky and plastic; few fine and medium roots; few fine and very fine pores; 25 percent rock fragments, dominantly stones; slightly calcareous, lime segregated on rock fragments; neutral (pH 7.2); gradual, wavy boundary.

C1ca—41 to 53 inches, light yellowish-brown (10YR 6/4) stony heavy loam, dark yellowish brown (10YR 4/4) when moist; massive; hard, friable, slightly sticky and slightly plastic; few fine and medium roots; few fine and medium pores; 30 percent rock fragments, dominantly stones; moderately calcareous, lime segregated on rock fragments; neutral (pH 7.2); gradual, wavy boundary.

C2ca—53 to 60 inches, light yellowish-brown (10YR 6/4) very stony loam, dark yellowish brown (10YR 4/4) when moist; massive; hard, friable, slightly sticky and slightly plastic; few fine and medium roots; few fine pores; 70 percent rock fragments; dominantly stones and cobbles; moderately calcareous, lime segregated on rock fragments; neutral (pH 7.2).

The soil is 60 inches or more deep.

The A horizon is 7 to 11 inches thick. It is dark brown, very dark grayish brown, brown, dark grayish brown, or grayish brown when dry and dark brown, very dark brown, or very dark grayish brown when moist. Reaction ranges from slightly acid to neutral.

The B2t horizon is 11 to 20 inches thick. It is yellowish brown, light yellowish brown, dark brown, brown, light brown, dark grayish brown, dark yellowish brown, grayish brown, light brownish gray, or pale brown when dry and dark brown, dark yellowish brown, very dark grayish brown, or dark grayish brown when moist. It ranges from clay loam or stony clay loam to sandy clay loam or stony sandy clay loam. Content of coarse fragments, stones, and cobbles ranges from few to 35 percent. Reaction ranges from slightly acid to neutral. Clay films are few and thin to continuous and thin.

The Cca horizon is light yellowish brown, brown, light brown, grayish brown, yellowish brown, pale brown, or light brownish gray when dry and dark yellowish brown, dark brown, brown, dark grayish brown, grayish brown, or yellowish brown when moist. The Cca horizon ranges from stony or very stony loam to stony or very stony silty clay loam; content of stones and cobbles is 35 to 70 percent, and lime content ranges from 3 to 30 percent. Reaction ranges from neutral to moderately alkaline. Depth to the Cca horizon ranges from 27 to 50 inches.

TGG—Tingey-Rock outcrop complex, 40 to 70 percent slopes. This mapping unit is on southern exposures of mountainsides. It is about 70 percent Tingey stony silt loam, 40 to 70 percent slopes, on side slopes; about 20 percent Rock outcrop on points and ridges; and

small areas of Lizzant very stony loam, 40 to 60 percent slopes; and Pritchett stony fine sandy loam, 30 to 70 percent slopes.

Runoff is medium on the Tingey soil, and the hazard of erosion is moderate.

This unit is used as summer range by sheep, cattle, deer, and elk. It is also used as winter range by deer and elk. Capability unit VIIs-M nonirrigated; Tingey soil in Mountain Loam (Oak) range site, Rock outcrop not assigned a range site.

TGH—Tingey-Rock outcrop complex, 70 to 80 percent slopes. This mapping unit is on northern exposures of mountainsides. It is about 70 percent Tingey very stony silt loam, 70 to 80 percent slopes, and about 20 percent Rock outcrop, mainly on points and ridges but scattered throughout the landscape. The rest is small areas of Bezzant very stony loam, 60 to 80 percent slopes, and Bradshaw very stony loam, 60 to 80 percent slopes.

The Tingey soil has a profile similar to the one described as representative of the Tingey series, but stones cover 10 to 25 percent of the surface. Runoff is rapid, and the hazard of erosion is severe.

The Tingey soils in this unit are too steep to have more than limited range use by sheep and cattle, but they are used as summer range by deer and elk. This mapping unit is also used as snow catchment areas for watersheds and for esthetic value. Capability unit VIIIe-X nonirrigated; Tingey soil in Mountain Loam (Oak) range site, Rock outcrop not assigned a range site.

Toehead Series

The Toehead series consists of well-drained soils that formed in alluvium derived from limestone, sandstone, and shale on alluvial fans. Toehead soils are commonly associated with Canburn, Clegg, Lizzant, and Watkins Ridge soils. Slope is 2 to 8 percent.

Elevation ranges from 6,100 to 6,800 feet. The average annual precipitation ranges from 14 to 16 inches, and the mean annual air temperature is 43° to 45° F. The frost-free period is 90 to 110 days. Vegetation is dominantly oakbrush, big sagebrush, and perennial grasses.

In a representative profile the surface layer is dark grayish-brown and dark-brown silt loam and silty clay loam about 22 inches thick. The substratum is brown and light brownish-gray silty clay loam to a depth of 60 inches.

Toehead soils are slightly calcareous to strongly calcareous. Permeability is moderately slow. The available water capacity is 8 to 12 inches. The water-supplying capacity of nonirrigated soils is 11 to 13 inches annually. The effective root zone is 60 inches or more.

Toehead soils are used for irrigated and nonirrigated alfalfa, small grain, and pasture. They are also used as range.

Representative profile of Toehead silt loam, 2 to 4 percent slopes, in a cultivated field 3 miles north of Fairview, east of the railroad tracks, about 1,815 feet east and 330 feet north of the southwest corner of sec. 13, T. 13 S., R. 4 E., Sanpete County:

- Ap1—0 to 7 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, subangular blocky structure; hard, firm, sticky and plastic; few fine, medium, and very fine roots; few fine pores; moderately calcareous; neutral (pH 7.2); clear, smooth boundary.
- A12—7 to 14 inches, dark grayish-brown (10YR 4/2) silt loam, dark brown (10YR 3/3) when moist; moderate, medium, subangular blocky structure; very hard, firm, sticky and plastic; few fine and medium roots; common fine and very fine pores; moderately calcareous; neutral (pH 7.2); clear, smooth boundary.
- A13—14 to 22 inches, dark brown (10YR 4/3) silty clay loam, dark brown (10YR 3/3) when moist; weak, medium, prismatic structure parting to moderate, medium, angular blocky; very hard, firm, sticky and plastic; few very fine roots; common fine pores; slightly calcareous; moderately alkaline (pH 8.2); gradual, wavy boundary.
- C1—22 to 28 inches, brown (10YR 5/3) silty clay loam, dark brown (10YR 3/3) when moist; moderate, medium, angular blocky structure; extremely hard, firm, sticky and plastic; few fine and very fine roots; few fine and very fine pores; moderately calcareous, lime in fine veins; moderately alkaline (pH 8.2); gradual, wavy boundary.
- C2—28 to 41 inches, light brownish-gray (10YR 6/2) silty clay loam, dark grayish brown (10YR 4/2) when moist; moderate, fine, angular blocky structure; very hard, firm, sticky and plastic; few very fine roots; few very fine pores; moderately calcareous, lime in common fine veins; moderately alkaline (pH 8.4); gradual, smooth boundary.
- C3—41 to 60 inches, light brownish-gray (10YR 6/2) silty clay loam, dark grayish brown (10YR 4/2) when moist; massive; very hard, firm, sticky and plastic; few very fine and fine roots; few very fine pores; moderately calcareous, lime in veins and nodules; moderately alkaline (pH 8.4).

The soil is more than 60 inches deep. It ranges from silty clay loam to clay loam between depths of 10 and 40 inches.

The A horizon is 20 to 35 inches thick. It is dark grayish brown, dark brown, brown, or grayish brown when dry and very dark grayish brown or dark brown when moist. It ranges from silt loam to silty clay loam. Reaction is mildly alkaline to moderately alkaline.

The C horizon is brown, light brownish gray, light brown, pink, light yellowish brown, pale brown, or very pale brown when dry and dark brown, dark grayish brown, brown, dark yellowish brown, or yellowish brown when moist. Reaction is mildly alkaline to strongly alkaline. The C horizon ranges from silty clay loam to silty clay below a depth of 40 inches.

ToB—Toehead silt loam, 2 to 4 percent slopes. This soil is on alluvial fans. It has the profile described as representative of the series. Runoff is medium, and the hazard of erosion is slight.

Included with this soil in mapping are small areas of Toehead silt loam, 4 to 8 percent slopes; Watkins Ridge silt loam, 1 to 6 percent slopes; and Clegg loam, 3 to 10 percent slopes.

This soil is used for irrigated and nonirrigated alfalfa, small grain, and pasture. It is also used as range. Capability units IIIe-3 irrigated, IIIe-U nonirrigated; Upland Loam range site.

ToC—Toehead silt loam, 4 to 8 percent slopes. This soil is on alluvial fans. Runoff is medium, and the hazard of erosion is moderate. In a few places cobbles cover 2 percent of the surface.

Included with this soil in mapping are small areas of Toehead silt loam, 2 to 4 percent slopes; Toehead silt loam, thin surface variant, 4 to 20 percent slopes; and Clegg loam, 3 to 10 percent slopes.

This soil is used mainly as range. It is also used for irrigated and nonirrigated alfalfa and pasture. Cap-

ability units IIIe-3 irrigated, IIIe-U nonirrigated; Upland Loam range site.

Toehead Variant

This variant consists of well-drained soils that formed in alluvium derived from limestone, sandstone, and shale on alluvial fans. Slope is 4 to 20 percent.

Elevation ranges from 5,800 to 6,500 feet. The average annual precipitation ranges from 12 to 16 inches, and the mean annual air temperature is 43° to 45° F. The frost-free period is 90 to 110 days. Vegetation is dominantly big sagebrush, rabbitbrush, and perennial grass.

In a representative profile the surface layer is brown silt loam about 17 inches thick. The substratum is pale-brown and light yellowish-brown silt loam to a depth of 60 inches.

These soils are strongly calcareous. Permeability is moderate. The available water capacity is 8 to 12 inches. The water-supplying capacity is 8 to 13 inches annually. The effective root zone is 60 inches or more.

These soils are used as range.

Representative profile of Toehead silt loam, thin surface variant, 4 to 20 percent slopes, in a nonirrigated pasture in South Hollow east of Mayfield, about 1,815 feet north and 500 feet west of the southeast corner of sec. 3, T. 20 S., R. 2 E., Sanpete County:

- A11—0 to 3 inches, brown (10YR 5/3) silt loam, dark brown (10YR 3/3) when moist; weak, medium, platy structure; soft, friable, slightly sticky and plastic; many fine roots; few very fine pores; strongly calcareous; strongly alkaline (pH 8.6); abrupt, smooth boundary.
- A12—3 to 17 inches, brown (10YR 5/3) silt loam, dark brown (10YR 3/3) when moist; weak, coarse, prismatic structure parting to weak, medium, subangular blocky; slightly hard, friable, slightly sticky and plastic; common fine and very fine roots; few very fine pores; strongly calcareous; strongly alkaline (pH 8.6); clear, smooth boundary.
- C1—17 to 25 inches, pale-brown (10YR 6/3) silt loam, dark brown (10YR 4/3) when moist; massive; hard, friable, slightly sticky and plastic; common very fine roots; few fine and very fine pores; strongly calcareous; strongly alkaline (pH 8.6); clear, smooth boundary.
- C2—25 to 40 inches, pale-brown (10YR 6/3) silt loam, dark brown (10YR 4/3) when moist; massive; hard, friable, slightly sticky and plastic; common very fine roots; few fine and very fine pores; strongly calcareous; strongly alkaline (pH 8.6); gradual, wavy boundary.
- C3—40 to 60 inches, light yellowish-brown (10YR 6/4) silt loam, dark yellowish brown (10YR 4/4) when moist; massive; hard, friable, slightly sticky and plastic; strongly calcareous; strongly alkaline (pH 9.0).

The soil is more than 60 inches deep. It ranges from silt loam to silty clay loam between depths of 10 and 40 inches.

The A horizon is 9 to 20 inches thick. It is brown to grayish brown when dry and dark brown to very dark grayish brown when moist. The A horizon is moderately calcareous to strongly calcareous, and reaction is moderately alkaline to strongly alkaline.

The C horizon is pale brown to brown or light yellowish brown when dry and dark brown to dark grayish brown or dark yellowish brown when moist. The C horizon is strongly calcareous, and reaction is strongly alkaline to very strongly alkaline.

TSD—Toehead silt loam, thin surface variant, 4 to 20 percent slopes. This soil is on alluvial fans and small mountain valley bottoms. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Toehead silt loam, 2 to 4 percent slopes; Toehead silt loam, 4 to 8 percent slopes; and Watkins Ridge silt loam, 1 to 6 percent slopes.

This soil is used as range or pasture. Successful grass seedings have been made on this soil. Capability unit IIIe-U nonirrigated; Upland Loam range site.

Torrifluvents and Torriorthents, Stony

TT—Torrifluvents and Torriorthents, stony consist of extremely stony alluvium derived from a variety of sedimentary rocks. They are mainly on flood plains of live and ephemeral streams, but are also on mud-rock flows and alluvial cones. They range from sandy loam to loam. Gravel, cobbles, and stones make up 50 to 80 percent of the alluvium, which is typically dominated by stones. The content of stones and cobbles varies significantly within a few feet. There are usually shallow and deep gullies, and sheet and rill erosion are active. Vegetation is dominantly big sagebrush, shadscale, yellowbrush, and Indian ricegrass.

These soils are used as range. Capability unit VIIs-S nonirrigated; Semi-desert Stony Loam range site.

Toze Series

The Toze series consists of well-drained soils that formed in alluvium derived from limestone, shale, and dolomite on mountainsides, usually in pockets and on alluvial fans. Toze soils are commonly associated with Kitchell, Tingey, and Zeesix soils. Slope is 4 to 25 percent.

Elevation ranges from 7,500 to 9,000 feet. The average annual precipitation ranges from 25 to 30 inches, and the mean annual air temperature ranges from 38° to 45° F. The frost-free period is 80 to 90 days. Vegetation is dominantly big sagebrush, snowberry, chokeberry, and perennial grasses.

In a representative profile the surface layer is very dark grayish-brown and dark grayish-brown gravelly silt loam and gravelly loam about 35 inches thick. The substratum is light-gray, very pale brown, and white gravelly and very gravelly very fine sandy loam to a depth of 60 inches.

The Toze soils are strongly calcareous. Permeability is moderate. The available water capacity is 6 to 8 inches. The water-supplying capacity is 14 to 18 inches annually. The effective root zone is about 60 inches.

Toze soils are used as summer range by sheep, cattle, deer, and elk.

Representative profile of Toze gravelly loam, 4 to 25 percent slopes, in a range area about 2 miles north-east of "the grove" on Manti Mountain, about 2,400 feet north and 3,200 feet west of the southeast corner of sec. 36, T. 17 S., R. 3 E., Sanpete County:

A11—0 to 3 inches, very dark grayish-brown (10YR 3/2) gravelly silt loam, very dark brown (10YR 2/2) when moist; weak, very fine, granular structure; soft, friable, nonsticky and slightly plastic; common fine and very fine roots; few fine pores; 20 percent gravel; noncalcareous; mildly alkaline (pH 7.4); abrupt, smooth boundary.

A12—3 to 9 inches, very dark grayish-brown (10YR 3/2) gravelly silt loam, very dark brown (10YR 2/2) when

moist; weak, coarse, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few medium, few fine, and common very fine roots; few very fine and fine pores; 20 percent gravel; noncalcareous; mildly alkaline (pH 7.6); gradual, smooth boundary.

A13—9 to 22 inches, dark grayish-brown (10YR 4/2) gravelly loam, very dark brown (10YR 2/2) when moist; weak, medium, subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few medium, few fine, few very fine roots; few fine pores; 20 percent gravel; noncalcareous to slightly calcareous; mildly alkaline (pH 7.8); gradual, smooth boundary.

A14—22 to 35 inches, dark grayish-brown (10YR 4/2) gravelly silt loam, very dark grayish brown (10YR 3/2) when moist; massive; hard, friable, slightly sticky and slightly plastic; few fine and very fine roots; few fine and very fine pores; 35 percent gravel and cobbles; strongly calcareous; strongly alkaline (pH 8.6); clear, wavy boundary.

C2ca—35 to 43 inches, light-gray (10YR 7/2) gravelly very fine sandy loam, pale brown (10YR 6/3) when moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; few very fine pores; 35 percent gravel and cobbles; very strongly calcareous; strongly alkaline (pH 9.0); gradual, smooth boundary.

C3ca—43 to 52 inches, very pale brown (10YR 7/3) gravelly very fine sandy loam, pale brown (10YR 6/3) when moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; few fine pores; 35 percent gravel and cobbles; very strongly calcareous, lime in veins; strongly alkaline (pH 9.0); clear, smooth boundary.

C4ca—52 to 60 inches, white (10YR 8/2) very gravelly very fine sandy loam, pale brown (10YR 6/3) when moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine pores; 50 percent gravel and cobbles; very strongly calcareous; very strongly alkaline (pH 9.2).

The soil is 60 inches or more deep. It ranges from gravelly silt loam to gravelly silty clay loam between depths of 10 and 40 inches. Content of gravel and cobbles averages about 20 percent but ranges from 5 to 35 percent.

The A horizon is 16 to 38 inches thick. It is very dark grayish brown, dark brown, or dark grayish brown when dry and very dark brown, dark brown, or very dark grayish brown when moist. The A horizon is slightly calcareous to strongly calcareous, and reaction is neutral to strongly alkaline.

The Cca horizon is light gray, white, very pale brown, brown, light brown, pink, grayish brown, light brownish gray or pale brown when dry and pale brown, dark brown, brown, light brown, dark grayish brown, or grayish brown when moist. The Cca horizon has its upper boundary above a depth of 40 inches. It is strongly calcareous to very strongly calcareous, and reaction ranges from mildly alkaline to very strongly alkaline. The Cca horizon ranges from gravelly very fine sandy loam to gravelly silty clay. Content of gravel and cobbles ranges from 30 to 50 percent.

TVD—Toze gravelly loam, 4 to 25 percent slopes. This soil is on foothills and alluvial fans. It is in small areas. Runoff is medium, and the hazard of erosion is severe.

Included with this soil in mapping are small areas of Zeesix stony silt loam, 8 to 40 percent slopes.

This soil is used as summer range by sheep, cattle, deer, and elk. It is also used as a water catchment area for watersheds. Capability unit VIe-H nonirrigated; High Mountain Loam range site.

Wales Series

The Wales series consists of well-drained soils that formed in alluvium derived from sandstone, shale, and

limestone on alluvial fans, alluvial plains, and small mountain valley bottoms. Wales soils are commonly associated with Amtoft, Atepic, Borvant, and Woodrow soils. Slope is 0 to 8 percent.

Elevation ranges from 5,400 to 6,000 feet. The average annual precipitation ranges from 11 to 14 inches, and the mean annual air temperature ranges from 45° to 49° F. The frost-free period is 100 to 110 days. Vegetation is dominantly big sagebrush, rabbitbrush, and perennial grasses.

In a representative profile the surface layer is brown loam about 11 inches thick. The substratum is very pale brown and light-brown loam and gravelly fine sandy loam to a depth of 60 inches.

The Wales soils are strongly calcareous, and reaction is mildly alkaline to strongly alkaline. Permeability is moderate. The effective root zone is 60 inches or more.

Wales soils are used for irrigated alfalfa, corn, small grain, and pasture. They are also used for non-irrigated grass pasture and as range.

Representative profile of Wales loam, 2 to 8 percent slopes, in a range area on the west side of South Valley in the Valley Mountains west of Gunnison, about 1,980 feet north and 1,238 feet west of the southeast corner of sec. 3, T. 20 S., R. 1½ W., Sanpete County:

A11—0 to 4 inches, brown (10YR 5/3) loam, dark brown (10YR 4/3) when moist; weak, thin, platy structure; slightly hard, firm, sticky and plastic; common very fine, few fine and medium roots; few fine and very fine pores; strongly calcareous; moderately alkaline (pH 8.2); abrupt, smooth boundary.

A12—4 to 11 inches, brown (10YR 5/3) loam, dark brown (10YR 4/3) when moist; weak, medium and fine, granular structure; hard, firm, sticky and plastic; common fine and very fine and few medium pores; strongly calcareous; moderately alkaline (pH 8.4); clear, smooth boundary.

C1—11 to 22 inches, very pale brown (10YR 7/3) loam, brown (10YR 5/3) when moist; moderate, medium, angular blocky structure; very hard, firm, sticky and plastic; few fine, very fine, and medium roots; common very fine and fine and few medium pores; few krotovinas; strongly calcareous, lime in very fine veins and flakes; moderately alkaline (pH 8.4); clear, smooth boundary.

C2—22 to 39 inches, very pale brown (10YR 7/4) loam, light yellowish brown (10YR 6/4) when moist; moderate, coarse, angular blocky structure; very hard, firm, sticky and plastic; few very fine and fine roots; common very fine, few medium and coarse pores; few krotovinas; strongly calcareous, lime in fine veins and flakes; moderately alkaline (pH 8.4); clear, wavy boundary.

C3—39 to 50 inches, light-brown (7.5YR 6/3) gravelly fine sandy loam, brown (7.5YR 5/3) when moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine and very fine roots; 20 percent gravel; strongly calcareous; strongly alkaline (pH 8.5); clear, wavy boundary.

C4—50 to 60 inches, very pale brown (10YR 7/4) light loam, yellowish brown (10YR 5/4) when moist; massive; hard, friable, slightly sticky and plastic; few very fine roots; few very fine and fine pores; strongly calcareous; strongly alkaline (pH 8.6).

The soil is 60 inches or more deep. Between depths of 10 and 40 inches it averages loam or silt loam but ranges to silty clay loam or clay loam. Content of gravel is 0 to 20 percent.

The A horizon is 8 to 12 inches thick. It is brown, light brown, grayish brown, yellowish brown, light brownish gray, pale brown, or light yellowish brown when dry and dark brown, very dark grayish brown, dark yellowish brown, or dark grayish brown when moist. Only the upper 4 inches

is brown or grayish brown when dry and very dark grayish brown, dark brown, or dark yellowish brown when moist. Reaction ranges from mildly alkaline to moderately alkaline.

The C horizon is very pale brown, brown, light brown, pink, grayish brown, pale brown, or light yellowish brown when dry and brown, dark brown, dark grayish brown, grayish brown, light brownish gray, pale brown, light yellowish brown, or yellowish brown when moist. Reaction ranges from moderately alkaline to strongly alkaline. Below a depth of 40 inches the C horizon ranges from clay loam, loam, or silt loam, to gravelly or very gravelly clay loam, loam, or sandy loam. Content of gravel is as much as 70 percent.

WAC—Wales loam, 2 to 8 percent slopes. This soil is on alluvial fans and valley bottoms. It occupies large areas. It has the profile described as representative of the series. Runoff is medium, and the hazard of erosion is moderate. There are occasional deep and shallow gullies, and in places sheet and rill erosion are active. The average annual precipitation ranges from 12 to 14 inches. The available water capacity is 8 to 11 inches. The water-supplying capacity is 8 to 10 inches annually.

Included with this soil in mapping are small areas of Fontreen cobbly loam, 4 to 20 percent slopes, and Atepic shaly clay loam, 10 to 30 percent slopes.

This soil has been mostly seeded to crested wheatgrass. It is also used as range. Capability unit IVE-UZ nonirrigated; Upland Loam range site.

WcA—Wales silty clay loam, low rainfall, 0 to 2 percent slopes. This soil is in fairly large areas on alluvial plains. It has a profile similar to the one described as representative of the series, but it has a surface layer of silty clay loam. It is mainly gravelly clay loam between depths of 20 and 40 inches. Content of gravel is about 20 percent. Below a depth of 40 inches, it is gravelly or very gravelly clay loam, loam, or sandy loam, and content of gravel is 35 to 70 percent. The average annual precipitation is 11 inches or slightly less. Runoff is slow, and the hazard of erosion is slight. The available water capacity is 5 to 8 inches. The water-supplying capacity of nonirrigated soils is 5 to 7 inches annually.

Included with this soil in mapping are small areas of Centerfield silty clay loam, 1 to 2 percent slopes; Sigurd gravelly loam, 1 to 5 percent slopes; and Woodrow silty clay loam, 0 to 2 percent slopes.

This soil is used mainly for irrigated alfalfa, corn silage, small grain, and pasture. It is also used as range. Capability units IIe-2 irrigated, VIIe-S non-irrigated; Semi-desert Loam range site.

WcB—Wales silty clay loam, low rainfall, 2 to 5 percent slopes. This soil is on alluvial fans. It has a profile similar to the one described as representative of the series, but the surface layer is silty clay loam and gravelly clay loam is typically at some depth between 20 and 40 inches. Content of gravel is about 20 percent. Below a depth of 40 inches the soil is gravelly or very gravelly clay loam, loam, or sandy loam, and content of gravel is 35 to 70 percent. The average annual precipitation is 11 inches or slightly less. Runoff is medium, and the hazard of erosion is moderate. Sheet and rill erosion are common on most cultivated fields. The available water capacity is 5 to 8 inches. The water-supplying capacity of nonirrigated soils is 5 to 7 inches annually.

Included with this soil in mapping are small areas of Centerfield silty clay loam, 2 to 5 percent slopes, eroded; Sigurd gravelly loam, 1 to 5 percent slopes; and Woodrow silty clay loam, 2 to 5 percent slopes.

This soil is used mainly for irrigated alfalfa, small grain, and pasture. It is also used as range. This soil is a good source of road fill below a depth of 30 to 40 inches. Capability units IIIe-2 irrigated, VIIe-S non-irrigated; Semi-desert Loam range site.

Wallsburg Series

The Wallsburg series consists of well-drained soils that are 10 to 20 inches deep over bedrock. These soils formed in residuum and colluvium on mountainsides and ridges. Wallsburg soils are commonly associated with Bagard, Harkers, and Yeates Hollow soils and Rock outcrop. Slope is 20 to 70 percent.

Elevation ranges from 5,500 to 8,100 feet, but above an elevation of 7,500 feet the soils are only on southern slopes. The average annual precipitation ranges from 18 to 25 inches, and the mean annual air temperature ranges from 42° to 45° F. The frost-free period is 80 to 100 days. Vegetation is dominantly big sagebrush, oakbrush, scattered juniper, and perennial grasses.

In a representative profile the surface layer is dark grayish-brown very stony and stony loam about 6 inches thick. The subsoil is dark-brown and brown very cobbly clay about 11 inches thick. Bedrock is at a depth of about 17 inches.

Reaction is slightly acid to mildly alkaline. Permeability is moderate. The available water capacity is 1½ to 2 inches. The water-supplying capacity is 6 to 7 inches annually. Roots penetrate 10 to 20 inches to the top of the bedrock.

Wallsburg soils are used as spring and summer range by sheep, cattle, deer, and elk.

Representative profile of Wallsburg very stony loam, 20 to 40 percent slopes, in a range area on Mount Baldy west of Indianola, about 2,310 feet east and 330 feet north of the southwest corner of sec. 22, T. 12 S., R. 3 E., Sanpete County:

- A11—0 to 2 inches, dark grayish-brown (10YR 4/2) very stony loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, granular structure; soft, firm, slightly sticky and slightly plastic; few fine and very fine roots; few fine pores; stones cover 10 to 15 percent of the surface; slightly acid (pH 6.1); abrupt, smooth boundary.
- A12—2 to 6 inches, dark grayish-brown (10YR 4/2) stony heavy loam, very dark brown (10YR 2/2) when moist; weak, medium, subangular blocky structure; slightly hard, firm, slightly sticky and plastic; common fine and medium and few very fine roots; few fine pores; 40 percent angular cobbles and stones; slightly acid (pH 6.2); clear, smooth boundary.
- B21t—6 to 12 inches, dark-brown (10YR 4/3) very cobbly light clay, dark brown (10YR 3/3) when moist; moderate, medium, angular blocky structure; very hard, very firm, sticky and plastic; common fine, few medium and coarse roots; few very fine pores; few moderately thick clay films on faces of peds, on gravel, and in pores; 60 percent angular cobbles; slightly acid (pH 6.4); gradual, wavy boundary.
- B22t—12 to 17 inches, brown (10YR 5/3) very cobbly light clay, dark brown (10YR 3/3) when moist; massive; very hard, very firm, sticky and plastic; few fine roots; few moderately thick clay films; 80 percent

angular cobbles and gravel; neutral (pH 6.6); abrupt, wavy boundary.

R—17 inches, basic igneous bedrock: fractures are filled with clay and some roots.

The soil is 10 to 20 inches deep over bedrock.

The A horizon is 6 to 10 inches thick. It is dark grayish brown, grayish brown, dark brown, or brown when dry and very dark brown, very dark grayish brown, or dark brown when moist. It ranges from very stony or very cobbly loam to stony or very stony, cobbly or very cobbly sandy clay loam.

The B2t horizon is dark brown, brown, dark grayish brown, or grayish brown when dry and very dark brown, dark brown, or very dark grayish brown when moist. It is cobbly or very cobbly heavy clay loam or light clay. Content of cobbles and gravel ranges from 35 to 80 percent.

WDE—Wallsburg very stony loam, 20 to 40 percent slopes. This soil is in small areas on mountainsides and ridges. It has the profile described as representative of the series. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Yeates Hollow stony silt loam, 20 to 40 percent slopes, and Harkers stony silt loam, 25 to 40 percent slopes.

This soil is used as spring and summer range by sheep, cattle, deer, and elk. Capability unit VIIs-M non-irrigated; Mountain Shallow Loam range site.

WEG—Wallsburg-Rock outcrop complex, 40 to 70 percent slopes. This mapping unit is on southern exposures of mountainsides. It is about 60 percent Wallsburg very stony loam, 40 to 70 percent slopes, on the side slopes; 25 percent Rock outcrop on points and ridges; about 15 percent Yeates Hollow stony silt loam, 20 to 40 percent slopes; and small areas of Bagard very stony clay loam, 10 to 40 percent slopes.

Runoff is medium on the Wallsburg soil, and the hazard of erosion is severe.

This soil is used as spring and summer range by sheep and deer. Capability unit VIIs-M nonirrigated; Wallsburg soil in Mountain Shallow Loam range site, Rock outcrop not assigned a range site.

Watkins Ridge Series

The Watkins Ridge series consists of well-drained soils that formed in alluvium derived from limestone, sandstone, and shale on alluvial fans. Watkins Ridge soils are commonly associated with Canburn, Clegg, and Toehead soils. Slope is 1 to 25 percent.

Elevation ranges from 6,000 to 6,800 feet. The average annual precipitation ranges from 12 to 20 inches, and the mean annual air temperature ranges from 43° to 44° F. The frost-free period is 80 to 100 days. Vegetation is dominantly oakbrush, big sagebrush, snowberry, and perennial grasses.

In a representative profile the surface layer is dark grayish-brown and brown silt loam about 16 inches thick. The substratum is brown and yellowish-brown strongly calcareous silt loam to a depth of 60 inches.

The Watkins Ridge soils are calcareous, and reaction is mildly alkaline to strongly alkaline. Permeability is moderate. The available water capacity is 8 to 12 inches. The effective root zone is about 60 inches.

Watkins Ridge soils are used mainly as range. They are also used for nonirrigated and irrigated alfalfa, small grain, and pasture.

Representative profile of Watkins Ridge silt loam, 1 to 6 percent slopes, in a range area about 2 miles north of the Milburn church, about 1,897 feet north and 825 feet west of the southeast corner of sec. 36, T. 12 S., R. 4 E., Sanpete County:

- A11—0 to 2 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; weak, medium, platy structure; slightly hard, friable, slightly sticky and plastic; few fine and medium roots; few fine pores; moderately calcareous; mildly alkaline (pH 7.8); abrupt, smooth boundary.
- A12—2 to 11 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, subangular blocky structure; slightly hard, firm, slightly sticky and plastic; few fine and medium roots; few fine and medium pores; moderately calcareous; mildly alkaline (pH 7.8); clear, smooth boundary.
- A13—11 to 16 inches, brown (10YR 5/3) silt loam, dark brown (10YR 3/3) when moist; weak, medium, subangular blocky structure; hard, firm, slightly sticky and plastic; few fine and medium roots; few fine pores; strongly calcareous; strongly alkaline (pH 8.5); gradual, smooth boundary.
- C1ca—16 to 25 inches, brown (7.5YR 5/3) silt loam, dark brown (7.5YR 4/2) when moist; moderate, medium, subangular blocky structure; hard, firm, slightly sticky and plastic; few fine and very fine roots; few fine pores; 20 percent gravel; few krotovinas; strongly calcareous, lime in fine veins; strongly alkaline (pH 8.8); clear, smooth boundary.
- C2ca—25 to 42 inches, yellowish-brown (10YR 5/4) silt loam, dark brown (10YR 4/3) when moist; massive; hard, firm, slightly sticky and plastic; few very fine roots; few very fine pores; 10 percent gravel; strongly calcareous, lime in fine veins; strongly alkaline (pH 8.8); gradual, smooth boundary.
- C3—42 to 60 inches, brown (7.5YR 5/4) silt loam, dark brown (7.5YR 4/3) when moist; massive; hard, firm, slightly sticky and plastic; no roots; few fine pores; strongly calcareous, lime in fine veins; strongly alkaline (pH 8.8).

The soil is more than 60 inches deep. Between depths of 10 and 40 inches it is typically loam or silt loam but ranges to light clay loam. Content of rock fragments is 0 to 30 percent.

The A horizon is 7 to 16 inches thick. It is dark grayish brown, dark brown, brown, or grayish brown when dry and very dark brown, dark brown, or very dark grayish brown when moist. The A horizon is slightly calcareous to strongly calcareous, and reaction is mildly alkaline to strongly alkaline.

The Cca horizon is 20 to 37 inches thick. It is brown, yellowish brown, light brown, pinkish gray, pink, light brownish gray, pale brown, or very pale brown when dry and dark brown, brown, light brown, dark grayish brown, grayish brown, light brownish gray, pale brown, yellowish brown, or light yellowish brown when moist. The Cca horizon is strongly calcareous, and reaction is moderately alkaline to strongly alkaline. Color in the lower part of the C horizon is similar to that in the Cca horizon.

WGD—Watkins Ridge stony loam, high rainfall, 4 to 25 percent slopes. This soil is on alluvial fans. It has a profile similar to the one described as representative of the series, but stones and cobbles cover 2 to 5 percent of the surface. Runoff is medium, and the hazard of erosion is moderate. The average annual precipitation is 16 to 20 inches. The water-supplying capacity is 11 to 14 inches annually.

Included with this soil in mapping are small areas of Clegg loam, 3 to 10 percent slopes; Mower clay loam, 5 to 30 percent slopes; and Lizzant stony loam, 4 to 20 percent slopes.

This soil is used as spring and summer range by

sheep, cattle, and deer. Capability unit VIe-M non-irrigated; Mountain Loam range site.

WhB—Watkins Ridge silt loam, 1 to 6 percent slopes. This soil is on alluvial fans. It has the profile described as representative of the series. Runoff is medium, and the hazard of erosion is moderate. The average annual precipitation is 14 to 16 inches. The water-supplying capacity is 9 to 11 inches annually.

Included with this soil in mapping are small areas of Toehead silt loam, 2 to 4 percent slopes, and Clegg loam, 3 to 10 percent slopes.

This soil is used mainly for irrigated and nonirrigated alfalfa, small grain, and pasture. It is also used as range. Capability units IIIe-3 irrigated, IIIe-U non-irrigated; Upland Loam range site.

Woodrow Series

The Woodrow series consists of well-drained soils that formed in alluvium derived from shale, limestone, and sandstone on alluvial fans, alluvial plains, and flood plains. Woodrow soils are most commonly associated with Anco, Arapien, Genola, and Linoyer soils. Slopes are typically smooth and are 1 to 5 percent.

Elevation ranges from 5,000 to 6,000 feet. The average annual precipitation ranges from 8 to 12 inches, and the mean annual air temperature ranges from 45° to 51° F. The frost-free period is 115 to 130 days. Vegetation of the noncultivated areas is dominantly big sagebrush, shadscale, rabbitbrush, and perennial grasses.

In a representative profile the surface layer is pale-brown silty clay loam about 11 inches thick. The substratum is very pale brown clay loam and silt loam to a depth of 60 inches.

The Woodrow soils are strongly calcareous, and reaction is moderately alkaline to strongly alkaline. Permeability is moderately slow. The available water capacity is 8 to 12 inches. The water-supplying capacity of nonirrigated soils is 5 to 8 inches annually. The effective root zone is 60 inches or more.

Woodrow soils are used mainly for irrigated alfalfa, small grain, corn silage, sugar beets, and pasture. They are also used as range and as habitat by upland game birds and small game.

Representative profile of Woodrow silty clay loam, 0 to 2 percent slopes, in a cultivated field 2½ miles west, ½ mile south of Gunnison, about 2,800 feet south and 625 feet east of the northwest corner of sec. 23, T. 19 S., R. 1 W., Sanpete County:

- Ap—0 to 5 inches, pale-brown (10YR 6/3) silty clay loam, brown (10YR 5/3) when moist; weak, medium, subangular blocky structure; hard, firm, sticky and plastic; common very fine roots; few fine pores; strongly calcareous; strongly alkaline (pH 8.6); abrupt, smooth boundary.
- A12—5 to 11 inches, pale-brown (10YR 6/3) silty clay loam, brown (10YR 5/3) when moist; weak, medium, subangular blocky structure; hard, firm, sticky and plastic; few very fine, fine, and medium roots; few very fine, fine, and medium pores; strongly calcareous; strongly alkaline (pH 8.6); gradual, smooth boundary.
- C1—11 to 18 inches, very pale brown (10YR 7/3) clay loam, brown (10YR 5/3) when moist; weak, medium, subangular blocky structure; very hard, very firm, sticky and plastic; few very fine roots; common very fine,

few fine and medium pores; strongly calcareous; strongly alkaline (pH 8.6); clear, wavy boundary.

C2—18 to 36 inches, very pale brown (10YR 7/3) silty clay loam, brown (7.5YR 5/3) when moist; massive; hard, very firm, sticky and plastic; few fine and very fine and medium pores; strongly calcareous; strongly alkaline (pH 8.6); gradual, wavy boundary.

C3—36 to 48 inches, very pale brown (10YR 7/3) silt loam, brown (10YR 5/3) when moist; massive; hard, firm, sticky and plastic; few very fine roots; common very fine pores; very strongly calcareous; strongly alkaline (pH 8.8); gradual, wavy boundary.

C4—48 to 60 inches, very pale brown (10YR 7/3) heavy clay loam, brown (7.5YR 5/4) when moist; massive; very hard, very firm, sticky and very plastic; few very fine pores; strongly calcareous; strongly alkaline (pH 8.8).

The soil is more than 60 inches thick. It is dominantly silty clay loam or clay loam between depths of 10 and 40 inches, but thin lenses of silt loam or clay are common.

The A horizon is 7 to 12 inches thick. It is pale brown, brown, light brown, pink, grayish brown, light grayish brown, or very pale brown when dry and brown, dark brown, light brown, dark grayish brown, grayish brown, pale brown, or light brownish gray when moist.

The C horizon is very pale brown, light brown, pinkish gray, pink, light yellowish brown, or pale brown when dry and brown, dark brown, light brown, dark grayish brown, grayish brown, light brownish gray, or pale brown when moist. Below a depth of 40 inches the C horizon ranges from clay to loamy sand.

WoA—Woodrow silty clay loam, 0 to 2 percent slopes. This soil is on alluvial fans, alluvial plains, and flood plains. It has the profile described as representative of the series. Runoff is slow, and the hazard of erosion is slight.

Included with this soil in mapping are small areas of Genola loam, 0 to 2 percent slopes; Wales silty clay loam, low rainfall, 0 to 2 percent slopes; Quaker silty clay loam, 1 to 2 percent slopes; and Ephraim silty clay loam.

Most of the acreage of this soil is used for irrigated alfalfa, small grain, corn silage, sugar beets, and pasture. Some small areas are used as range. Capability units IIe-2 irrigated, VIIe-S nonirrigated; Semi-desert Loam range site.

WoC2—Woodrow silty clay loam, 2 to 5 percent slopes, eroded. This soil is on alluvial fans and alluvial plains. It has a profile similar to the one described as representative of the series, but it is eroded. Runoff is medium, and the hazard of erosion is moderate. There are a few deep gullies, and sheet and rill erosion are active in many cultivated fields.

Included with this soil in mapping are small areas of Quaker silty clay loam, 2 to 5 percent slopes; Genola loam, 2 to 5 percent slopes; and Wales silty clay loam, low rainfall, 2 to 5 percent slopes.

This soil is used mainly for irrigated alfalfa, small grain, and pasture. It is also used as range. Capability units IIIe-2 irrigated, VIIe-S nonirrigated; Semi-desert Loam range site.

Xerofluvents and Fluvaquents

XE—Xerofluvents and Fluvaquents consists of recently deposited alluvium on nearly level or gently sloping flood plains of streams or rivers. The alluvium is stratified and ranges from loamy sand to clay but is dominantly sandy loam, silt loam, loam, or clay loam.

Mottles typically are at depths between 20 and 40 inches, but in places they are almost to the surface or they are lacking. Depth to the water table ranges from 20 to 60 inches, depending on the season. Salinity is generally moderate, but it ranges from nonsaline to strongly saline affected. The strongly saline areas are typically small, less than one-half acre in size. Dominant vegetation is bluegrass, rubber rabbitbrush, willows, wiregrass, and annual weeds. The dominant vegetation on the strongly saline affected areas is salt grass, alkali sacaton, and greasewood.

This land type is used for pasture or grazing and in places for native grass hay. It is also used as habitat by upland game birds. Capability unit VIw-2 nonirrigated; Semi-wet Meadows range site.

Xerofluvents and Fluvaquents, Saline

XF—Xerofluvents and Fluvaquents, saline, consists of recently deposited alluvium on nearly level or gently sloping flood plains of streams or rivers. The alluvium is stratified and ranges from loamy sand to clay but is dominantly sandy loam, silt loam, or clay loam. It is strongly saline affected except along the Sevier River, where oxbows and meander scars are only moderately saline. There is typically a fluffy, granular salt crust on the surface. Vegetation is usually sparse and is greasewood, pickleweed, kochia, bassia, and saltgrass. Some places are barren. Mottles are typically between depths of 20 and 40 inches, but in places they are almost to the surface or are lacking. Depth to the water table ranges from 20 to 60 inches, depending on the season.

These soils are used as range. They are also used as habitat by upland game birds. Capability unit VIIw-28 nonirrigated; Alkali Bottoms range site.

Yeates Hollow Series

The Yeates Hollow series consists of well-drained soils that formed in alluvium and colluvium derived from mixed igneous and quartzite rocks on mountain-sides. Yeates Hollow soils are commonly associated with Deer Creek, Harkers, and Wallsburg soils. Slope is 20 to 40 percent.

Elevation ranges from 5,500 to 8,000 feet. The average annual precipitation ranges from 16 to 20 inches, and the mean annual air temperature is 38° to 43° F. The frost-free period is 70 to 90 days. Vegetation is oakbrush, snowberry, and perennial grasses.

In a representative profile the surface layer is very dark grayish-brown and dark-brown stony silt loam and stony silty clay loam about 10 inches thick. The subsoil is pale-brown, light yellowish-brown, light brown, and pink stony and very stony clay to a depth of 60 inches.

Reaction is strongly acid to neutral. Permeability is slow. The available water capacity is 4 to 7 inches. The water-supplying capacity is 7 to 9 inches annually. The effective root zone is 60 inches or more.

Yeates Hollow soils are used as summer range by sheep, cattle, deer, and elk.

Representative profile of Yeates Hollow stony silt loam, 20 to 40 percent slopes, in a range area south of

Mount Baldy, about 1,650 feet west and 1,815 feet south of the northeast corner of sec. 27, T. 12 S., R. 3 E., Sanpete County:

- A11—0 to 3 inches, very dark grayish-brown (10YR 3/2) stony silt loam, very dark brown (10YR 2/2) when moist; weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine and few medium and coarse roots; few very fine pores; stones and cobbles cover about 2 percent of the surface; neutral (pH 7.0); clear, smooth boundary.
- A12—3 to 10 inches, dark-brown (10YR 3/3) stony silty clay loam, very dark brown (10YR 2/2) when moist; moderate, medium, angular blocky structure; hard, firm, sticky and plastic; common fine and few medium and coarse roots; few fine pores; 25 percent rock fragments, mainly stones; neutral (pH 7.0); abrupt, wavy boundary.
- B21t—10 to 20 inches, pale-brown (10YR 6/3) stony clay, brown (10YR 5/3) when moist; strong, coarse, angular blocky structure; very hard, very firm, very sticky and very plastic; few coarse, fine, and very fine roots; continuous moderately thick clay films; 30 percent rock fragments, mainly stones; neutral (pH 6.8); gradual, wavy boundary.
- B22t—20 to 30 inches, light yellowish-brown (10YR 6/4) very stony clay, brown (7.5YR 5/4) when moist; moderate, coarse, angular blocky structure; extremely hard, extremely firm, very sticky and very plastic; few very fine, fine, and coarse roots; continuous moderately thick clay films; 60 percent rock fragments, mainly stones; slightly acid (pH 6.4); gradual, wavy boundary.
- B31—30 to 40 inches, light-brown (7.5YR 6/4) very stony clay, brown (7.5YR 5/3) when moist; massive; extremely hard, extremely firm, very sticky and very plastic; few medium and coarse roots; few moderately thick clay films; 70 percent rock fragments, mainly stones; slightly acid (pH 6.2); gradual, wavy boundary.
- B32—40 to 60 inches, pink (7.5YR 7/4) very stony clay, light brown (7.5YR 6/3) when moist; massive; extremely hard, extremely firm, very sticky and very plastic; few medium and coarse roots; few moderately thick clay films; 70 percent rock fragments, mainly stones; slightly acid (pH 6.2).

The soil is more than 60 inches deep. Content of coarse fragments ranges from 35 to 80 percent.

The A horizon is 8 to 14 inches thick. It is dark brown, brown, very dark grayish brown, dark grayish brown, or grayish brown when dry and very dark brown, dark brown, or very dark grayish brown when moist. Reaction is medium acid to neutral.

The B2t horizon is reddish brown, light reddish brown, brown, light brown, dark brown, pale brown, yellowish brown, or light yellowish brown when dry and reddish brown, dark reddish brown, dark brown, brown, dark yellowish brown, or yellowish brown when moist. It ranges from very stony clay to very cobbly clay. Reaction is strongly acid to neutral.

The B3 horizon is similar to the B2t horizon, but the B3 horizon does not have structure.

YHE—Yeates Hollow stony silt loam, 20 to 40 percent slopes. This soil is on mountainsides. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Harkers stony silt loam, 25 to 40 percent slopes, and Wallsburg very stony loam, 20 to 40 percent slopes.

This soil is used as summer range by sheep, cattle, deer, and elk. Capability unit VIs-M nonirrigated; Mountain Stony Loam range site.

Zeesix Series

The Zeesix series consists of well-drained soils that formed in alluvium and colluvium derived from lime-

stone on mountainsides. Zeesix soils are commonly associated with Lizzant and Toze soils. Slope is 8 to 40 percent.

Elevation ranges from 7,500 to 9,000 feet. The average annual precipitation ranges from 25 to 30 inches, and the mean annual air temperature ranges from 38° to 45° F. The frost-free period is 80 to 90 days. Vegetation is dominantly big sagebrush, snow-berry, and perennial grasses.

In a representative profile the surface layer is very dark gray stony silt loam and very dark grayish-brown gravelly silt loam and gravelly silty clay loam about 13 inches thick. The subsoil is pale-brown and very pale brown cobbly and very cobbly clay about 18 inches thick. The substratum to a depth of about 60 inches is pale-brown and very pale brown very cobbly clay and very cobbly clay loam.

The Zeesix soils are very strongly calcareous, and reaction is neutral to strongly alkaline. Permeability is moderate. The available water capacity is 6 to 9 inches. The water-supplying capacity is 14 to 20 inches annually. The effective root zone is 60 inches or more.

Zeesix soils are used as summer range by sheep, cattle, deer, and elk.

Representative profile of Zeesix stony silt loam, 8 to 40 percent slopes, in a range area 2 miles north of "The Grove" on Manti Mountain, about 900 feet east of the center of sec. 35, T. 17 S., R. 3 E., Sanpete County:

- A11—0 to 2 inches, very dark gray (10YR 3/1) stony silt loam, black (10YR 2/1) when moist; weak, fine, granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine discontinuous pores; 10 percent gravel; stones cover 2 percent of the surface; the soil matrix is non-calcareous, some lime is in fine gravel; neutral (pH 7.0); abrupt, smooth boundary.
- A12—2 to 5 inches, very dark grayish-brown (10YR 3/2) gravelly silt loam, very dark brown (10YR 2/2) when moist; weak, medium, subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; many very fine and fine roots; few fine pores; 20 percent gravel; the soil matrix is slightly calcareous, lime is more evident in fine gravel; neutral (pH 7.2); gradual, smooth boundary.
- A3—5 to 13 inches, very dark grayish-brown (10YR 3/2) gravelly silty clay loam, very dark brown (10YR 2/2) when moist; moderate, fine, angular blocky structure; hard, firm, sticky and plastic; common fine and very fine and few medium roots; common fine pores; 30 percent gravel; the soil matrix is slightly calcareous, lime is more evident in fine gravel; neutral (pH 7.2); clear, wavy boundary.
- B2t—13 to 23 inches, pale-brown (10YR 6/3) very cobbly clay, yellowish brown (10YR 5/4) when moist; weak, medium, prismatic structure parting to strong, fine, angular blocky; very hard, very firm, very sticky and plastic; few very fine and medium roots; few fine pores; thin continuous clay films on faces of peds; 50 percent cobbles and gravel; the soil matrix is slightly calcareous, lime is abundant in fine gravel; mildly alkaline (pH 7.6); gradual, wavy boundary.
- B3ca—23 to 31 inches, very pale brown (10YR 7/3) very cobbly clay, pale brown (10YR 6/3) when moist; moderate, medium, subangular blocky structure; very hard, very firm, very sticky and very plastic; few fine and very fine roots; few fine pores; few moderately thick clay films; 60 percent cobbles and gravel; very strongly calcareous, lime in fine nodules and veins; moderately alkaline (pH 8.2); gradual, wavy boundary.
- C1ca—31 to 47 inches, pale-brown (10YR 6/3) very cobbly clay, yellowish brown (10YR 5/4) when moist; weak,

fine, subangular blocky structure; very hard, very firm, very sticky and plastic; few fine and very fine roots; few very fine pores; 65 percent cobbles and gravel; very strongly calcareous, lime in veins, nodules, and segregated on rock fragments; moderately alkaline (pH 8.2); gradual, wavy boundary.

C2ca—47 to 60 inches, very pale brown (10YR 7/3) very cobbly clay loam, pale brown (10YR 6/3) when moist; massive; very hard, firm, very sticky and plastic; few fine and very fine roots; few very fine pores; 65 percent cobbles and gravel; very strongly calcareous, lime in veins, nodules, and segregated on rock fragments; moderately alkaline (pH 8.4).

The soil is more than 60 inches deep.

The A horizon is 8 to 15 inches thick. It is very dark gray, very dark grayish brown, dark gray, black, very dark brown, or dark grayish brown when dry and black or very dark brown when moist. It is noncalcareous to moderately calcareous, and reaction ranges from neutral to mildly alkaline.

The B2t horizon is 6 to 12 inches thick. It is pale brown, grayish brown, brown, yellowish brown, light yellowish brown, or light brownish gray to very pale brown or pale yellow when dry and yellowish brown, very dark grayish brown, dark brown, dark grayish brown, brown, or olive brown when moist. The B2t horizon ranges from cobbly or very cobbly clay or silty clay, to silty clay loam. Content of rock fragments ranges from 35 to 70 percent. Reaction ranges from neutral to mildly alkaline.

The B3ca horizon, where present, is similar to the B2t horizon, but reaction is mildly alkaline to moderately alkaline, and the content of lime is higher.

The Cca horizon is pale brown, very pale brown, light brownish gray, light yellowish brown, light gray, or pale yellow when dry and yellowish brown, pale brown, dark grayish brown, brown, light yellowish brown, or light brownish gray when moist. The Cca horizon is cobbly or very cobbly clay loam to cobbly clay, and reaction is mildly alkaline to strongly alkaline.

ZSE—Zeesix stony silt loam, 8 to 40 percent slopes. This soil is on mountainsides. It has the profile described as representative of the series. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Toze gravelly silt loam, 4 to 25 percent slopes; Lizzant very cobbly loam, 20 to 40 percent slopes; and Kitchell gravelly loam, 40 to 70 percent slopes.

This soil is used as summer range by sheep, cattle, deer, and elk. It is also used as a water catchment area for watersheds. Capability unit VIe-H nonirrigated; High Mountain Loam range site.

ZTE—Zeesix-Toze complex, 4 to 40 percent slopes. This mapping unit is on alluvial fans and mountainsides. It is about 55 percent Zeesix stony silty loam, 8 to 40 percent slopes, on ridges and the steeper slopes; about 30 percent Toze gravelly silt loam, 4 to 25 percent slopes, in pockets and swales and on alluvial fans; about 10 percent Skylick silt loam, 4 to 30 percent slopes; and small areas of Lizzant very cobbly loam, 20 to 40 percent slopes, and Kitchell gravelly loam, 40 to 70 percent slopes.

Runoff is medium on Zeesix soils, and the hazard of erosion is moderate. Runoff is medium on the Toze soils, and the hazard of erosion is slight.

This unit is used as catchment areas for watershed and as summer range by sheep, cattle, deer, and elk. Some small areas are used for aspen woodland. Capability unit VIe-H nonirrigated; High Mountain Loam range site.

Use and Management of the Soils

This section explains the system of capability classification used by the Soil Conservation Service and the system adopted by the State of Utah and used locally. It describes uses of the soils for irrigated and non-irrigated crops and pasture and as range, and gives estimated yields of the principal crops grown in the survey area. It also includes sections on the use of soils for wildlife; for building roads, ponds, and other engineering works; and for recreation areas.

The use of soils for crops, pasture, and wildlife is described by grouping similar soils that are suitable for those purposes and suggesting use and management for the group. In the section on engineering and recreation, the soils are not grouped but are placed in tables so that significant properties can be readily listed.

Crops and Pasture

Some practices are beneficial if applied to most of the soils used for crops and pasture. These practices are discussed here briefly.

An important management requirement is the safe and uniform distribution of irrigation water. Both the border and furrow (or corrugation) methods are suitable for row crops. Sprinklers are a suitable alternative method for most crops. Losses of soil and water can be held to a minimum by using proper length of runs and size of flows in furrows and borders. Some soils, such as Arapien and Lisade, are particularly subject to damage by irrigation water if it is not properly controlled.

The return of organic matter is particularly important to soils that are irrigated and cultivated, because it has a beneficial effect on soil structure. Sources of organic matter are crop residue, barnyard manure, and the sod crops grown in the cropping system. Practices that provide for regular additions of organic matter are ordinarily the most beneficial. The use of fertilizer in sufficient amounts to produce large increases in plant growth makes the return of increased amounts of organic matter to the soil possible.

The low content of organic matter in Arapien, Genola, Linoyer, Lisade, and Woodrow soils makes them especially susceptible to the formation of tillage pans. These soils, in particular, benefit from regular additions of organic material and commercial fertilizer. Good tilth can be maintained and the formation of tillage pans reduced if the soils are not tilled or trampled when wet. The formation of tillage pans can also be reduced by varying the depth of tillage and limiting the number of trips over the soil with tillage equipment.

Arapien and Lisade soils have a high content of lime that enables them to convert phosphates into a form that is not available to plants, especially legumes. Hence, heavy applications of phosphate fertilizers are beneficial to legumes grown on these soils. Most of the soils in this survey area are well supplied with potassium, calcium, iron, and magnesium. In some soils calcium carbonate is excessive and interferes with the

absorption of iron by fruit trees and other plants, causing their leaves to turn yellow.

Capability grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of crops. The soils are grouped according to their limitations when they are used for field crops, the risk of damage when they are so used, and the way in which they respond to treatment. The grouping does not take into account major, and generally expensive, landforming that would change slope, depth, or other characteristics of the soils, or possible, but unlikely, major reclamation projects. Nor does it apply to rice, cranberries, horticultural crops, or other crops requiring special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when they are used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils as range, for woodland, or for engineering.

In the capability system, the soils are grouped at three levels: the capability class, the subclass, and the unit. These are described in the following paragraphs.

CAPABILITY CLASSES, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants, require very careful management, or both.

Class V soils are subject to little or no erosion but have other limitations, impractical to remove, that limit their use largely to pasture, woodland, or wildlife.

Class VI soils have severe limitations that make them generally unsuitable for cultivation and limit their use largely to pasture, woodland, range, or wildlife.

Class VII soils have very severe limitations that make them unsuitable for cultivation and that restrict their use largely to pasture, woodland, range, or wildlife.

Class VIII soils and landforms have limitations that preclude their use for commercial crop production and restrict their use to recreation, wildlife habitat, water supply, or esthetic purposes.

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with

plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, not used in this survey area but used in other survey areas, shows that the chief limitation is climate that is too cold or too dry.

In class I (not used in this survey area) there are no subclasses because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in class V are subject to little or no erosion, although they have other limitations that restrict their use largely to pasture, woodland, recreation, range, or wildlife habitat.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suitable for the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding Arabic numbers, or numbers and letters, assigned locally, to the subclass symbol, for example, IIe-2, IIe-U, VIe-M, or VIIe-S. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter immediately following indicates the subclass, or kind of limitation. The part of the symbol following the hyphen specifically identifies the capability unit within the State system.

In the Utah system of classification, the numbers or capital letters following the subclass letter indicate the nature of the limitations. The numbers 2 or 3 in the first position show that the limitation is climate. The number 2 indicates a climate with a frost-free period of 110 to 130 days; the number 3 indicates a frost-free period of 80 to 110 days. The letters S, U, M, and H are for nonirrigated capability units and generally indicate the average annual precipitation.

The kind of plants that grow under a particular amount of annual precipitation vary according to elevation or aspect; therefore, the capability units show some overlapping in amounts of average annual precipitation. The letter S indicates that the average annual precipitation is generally 8 to 12 inches. The letter U indicates that it generally is 12 to 16 inches; the letter M indicates 16 to 24 inches; the letter H indicates 24 to 35 inches; and the letter Z indicates that the average annual precipitation for the unit is in the lower part of the range indicated. The number 3 means shallow soil; 4 means gravelly, cobbly, and stony soils that have low available water capacity; 5 means slow permeability; 8 means alkali or saline-alkali; E indicates potential for severe erosion; and X indicates coarse fragments on the surface.

On the following pages each capability unit in the survey area is described and the use and management are briefly discussed. The names of soil series represented are mentioned in the capability unit, but this does not mean that all of the soils of a given series are in that unit. To find the names of all the soils in any given capability unit, refer to the Guide to Mapping Units at the back of this survey.

CAPABILITY UNIT IIe-2 IRRIGATED

This capability unit consists of deep, moderately well drained to somewhat excessively drained soils on alluvial fans, alluvial plains, and valley bottoms. These soils are in the Arapien, Birdow, Calita, Centerfield, Doyce, Genola, Keigley, Linoyer, Lisade, Quaker, Ravola, Snake Hollow, Wales, and Woodrow series. The surface layer and underlying layers are mainly loam, very fine sandy loam, or silty clay loam. The Snake Hollow soil, however, has a gravelly fine sandy loam surface layer and a gravelly or very gravelly sandy loam underlying layer. The Centerfield and Wales soils are very gravelly sandy loam or very gravelly loam at some depths below 20 inches.

Slopes range from 0 to 4 percent. The average annual precipitation ranges from 8 to 14 inches, and the frost-free period is mainly 110 to 130 days. The Snake Hollow and Wales soils have a frost-free period of only 100 to 110 days, but their available heat unit is high enough for the production of comparable crop yields.

Permeability ranges from moderately slow to moderately rapid. Runoff is slow to medium, and the hazard of erosion is slight to moderate. The available water capacity generally ranges from 5 to 12 inches, but in the Centerfield, Snake Hollow, and Wales soils it ranges from 4 to 8 inches. The effective root zone is 60 inches or more.

The soils in this capability unit are used mainly for irrigated alfalfa, small grain, sugar beets, corn silage, potatoes, and pasture. A suitable cropping system is 4 years of alfalfa or pasture followed by 1 year each of barley for grain, sugar beets, corn silage, and barley with alfalfa seeded in the stubble.

Good tilth is easily maintained by plowing in fall, returning organic matter to the soil, and by avoiding tilling or trampling soils that are too wet. Crops other than legumes generally respond to addition of nitrogen fertilizer. All legumes and, generally, potatoes respond to applications of phosphates when the crops are seeded.

Furrow irrigation is well suited to row crops, and corrugations are suitable for small grain, alfalfa, and pasture. Border irrigation is suitable for alfalfa or pasture if slope is less than 3 percent. Sprinklers can be used satisfactorily. Irrigation water must be applied carefully to minimize soil loss.

CAPABILITY UNIT IIIe-2 IRRIGATED

This capability unit consists of deep, well-drained and somewhat excessively drained soils on alluvial fans and flood plains. These soils are in the Arapien, Birdow, Calita, Centerfield, Doyce, Genola, Linoyer, Lisade, Quaker, Rapho, Ravola, Wales, and Woodrow series. The surface layer and the underlying layers mainly range from loam or very fine sandy loam to clay loam or silty clay loam. The Rapho soil, however, has a surface layer of gravelly fine sandy loam and underlying layers of gravelly loam to very gravelly sandy loam, and the Centerfield and Wales soils are very gravelly sandy loam or very gravelly loam at some depth below 20 inches.

Slopes range from 2 to 8 percent. The average annual precipitation ranges from 8 to 14 inches, and the frost-

free period is generally 110 to 130 days. The Wales soils have a frost-free period of 100 to 110 days.

Permeability ranges from moderately slow to rapid. Runoff is medium, and the hazard of erosion ranges from moderate to severe. The available water capacity generally ranges from 5 to 12 inches. The available water capacity for Centerfield soil, however, is 4 to 7 inches and for Wales soil is 5 to 8 inches. The effective root zone is about 60 inches.

The soils in this capability unit are used mainly for irrigated alfalfa, alfalfa and grass for hay or pasture, and small grain. Slopes are mostly too steep for row crops grown downslope. Row crops can be grown on the contour. A suitable rotation is 5 or 6 years of alfalfa or grass and alfalfa grown for hay or pasture followed by 2 years of small grain.

Good tilth is easily maintained by plowing in fall, returning organic matter to the soil, and avoiding tilling or trampling the soil if it is too wet. Legumes generally respond to applications of phosphate, and small grains and grasses respond to applications of nitrogen.

Corrugation and controlled flooding from contour ditches are suitable methods of irrigation for alfalfa, pasture, and small grain. Sprinklers can also be used satisfactorily. Contour furrows should be used for irrigating row crops. Erosion control and efficient use of irrigation water are the main concerns of management. In order to minimize soil loss in cutting irrigation ditches, the ditches should be placed on the contour or adequate drop structures should be installed.

CAPABILITY UNIT IIIe-3 IRRIGATED

This capability unit consists of deep, well-drained soils on alluvial fans. These soils are in the Toehead and Watkins Ridge series. The surface layer and the underlying layers range from silt loam or loam to silty clay loam.

Slopes range from 2 to 8 percent. The average annual precipitation ranges from 14 to 16 inches, and the frost-free period is 80 to 110 days.

Permeability ranges from moderately slow to moderate. Runoff is medium, and the hazard of erosion ranges from slight to moderate. The available water capacity ranges from 8 to 12 inches. The effective root zone is about 60 inches.

The soils in this capability unit are used mainly for alfalfa, small grain, and pasture. Only two crops of alfalfa are grown because of the short frost-free period. A suitable rotation is 5 or 6 years of alfalfa or alfalfa and grass grown for hay or pasture followed by 2 years of small grain.

Good tilth is easily maintained by plowing in fall, returning organic matter to the soil, and avoiding tilling or trampling the soil if it is wet. All crops generally respond to applications of nitrogen fertilizer, and all legumes respond to applications of phosphate.

Corrugations, or small furrows, and controlled flooding from contour ditches are suitable methods of irrigation for alfalfa, pasture, and small grain. Sprinklers can also be used satisfactorily.

Smoothing and shaping the soil surface for erosion control and efficient use of irrigation water is the main concern of management. Smoothing and shaping pre-

vents water accumulation and concentration, thus minimizing soil losses. Small irrigation heads of water must also be used to minimize soil loss. Corrugations should be placed across the slope.

CAPABILITY UNIT IIIe-25 IRRIGATED

This capability unit consists of deep, well-drained soils on alluvial fans. The soils are in the Billings and Moroni series. They are silty clay loam to silty clay throughout.

Slopes range from 1 to 8 percent. The average annual precipitation ranges from 8 to 14 inches, and the frost-free period is 110 to 130 days.

Permeability is slow. Runoff is medium to rapid, and the hazard of erosion ranges from moderate to severe. The available water capacity is 8 to 12 inches. The effective root zone is 60 inches or more.

The soils in this capability unit are used mainly for irrigated alfalfa, small grain, and pasture. A suitable rotation is 5 or 6 years of alfalfa or grass and alfalfa grown for hay or pasture followed by 2 years of small grain.

Good tilth is maintained by plowing in fall, returning organic matter to the soil, and avoiding tilling or trampling the soil if it is wet. Legumes generally respond to applications of phosphate, and small grain and grasses respond to applications of nitrogen.

Corrugation and controlled flooding from contour ditches are suitable methods of irrigation for alfalfa, pasture, and small grain. Sprinklers can also be used satisfactorily. Erosion control and the efficient use of irrigation water are important concerns of management. Smoothing and shaping the soil surface improves water distribution and reduces soil loss.

CAPABILITY UNIT IIIe-M NONIRRIGATED

This capability unit consists of deep, well-drained soils on alluvial fans and valley bottoms and in depressions and swales. The soils are in the Clegg and Manila series. The surface layer is loam, and the subsoil is clay loam or clay.

Slopes range from 3 to 10 percent. The average annual precipitation ranges from 16 to 20 inches, and the frost-free period is 80 to 100 days.

Permeability ranges from slow to moderately slow. Runoff is medium, and the hazard of erosion is moderate. The water-supplying capacity ranges from 11 to 14 inches. The effective root zone is 60 inches or more.

On the Fountain Green Divide, the Manila soils are used for nonirrigated alfalfa, grass, and small grain. If cultivated soils are in grass or legumes about half of the time, erosion is controlled and organic-matter content, tilth, and good water intake can be maintained. In other areas the soils are used as range.

Stubble mulching and fall chisel plowing keep crop residues on the soil surface from the harvest of one crop to the planting of the next, thus minimizing soil loss. Stripcropping across the steeper slopes reduces runoff and controls erosion. The stripcropping sequence is usually wheat-fallow, grass, and legume strips in a systematic arrangement.

CAPABILITY UNIT IIIe-U NONIRRIGATED

This capability unit consists of deep, well-drained

soils on alluvial fans and plains. These are soils in the Ant Flat, Obrast, Toehead, and Watkins Ridge series and the Toehead variant. The surface layer ranges from loam or silt loam to clay loam, and the underlying layers range from silt loam or loam to clay.

Slopes range from 1 to 20 percent but are dominantly 1 to 8 percent. The average annual precipitation ranges from 12 to 16 inches, and the frost-free period is 80 to 115 days.

Permeability ranges from moderate to very slow. Runoff is slow to medium, and the hazard of erosion ranges from slight to moderate. The water-supplying capacity ranges from 9 to 13 inches. The effective root zone is 60 inches or more.

Some of the soils in this capability unit are used for nonirrigated alfalfa, grass, and small grain. If these soils are in grass or legumes about half of the time, the organic-matter content, tilth, and good water intake can be maintained and erosion controlled. Uncultivated areas are used as range.

Stubble mulching and fall chisel plowing keep crop residues on the soil surface from the harvest of one crop to the planting of the next, thus minimizing soil loss. Stripcropping across the steeper slopes reduces runoff and controls erosion. The stripcropping sequence is usually wheat-fallow and grass or legume strips in a systematic arrangement.

CAPABILITY UNIT IIIw-2 IRRIGATED

This capability unit consists mostly of deep, somewhat poorly drained soils on valley bottoms, flood plains, alluvial fans, and alluvial plains. These soils are in the Anco, Arapien, Beek, Dyreng, Ephraim, Green River and Shumway series. The surface layer and the underlying layers range mainly from loam or clay to silty clay loam or silty clay. The Arapien soil has a surface layer of fine sandy loam, and the Green River soils have underlying layers of fine sandy loam or sandy loam.

Slopes range from 0 to 3 percent. The average annual precipitation ranges from 8 to 14 inches, and the frost-free period is 110 to 140 days.

Permeability ranges from slow to moderate. Runoff is slow, and the hazard of erosion is slight. The available water capacity ranges from 6 to 12 inches. The effective root zone is 60 inches or more. The seasonal water table is at a depth of 30 to 60 inches or more. Some of these soils are slightly saline affected and contain areas that are strongly saline affected.

The soils in this capability unit are used mainly for irrigated small grain, alfalfa, corn silage, or improved pasture if they are drained. A suitable rotation is 4 years of alfalfa or grass and alfalfa grown for hay or pasture followed by 1 year of small grain and 1 year of corn.

Good tilth is easily maintained if the soils are plowed in fall and left rough during winter, if organic matter is returned to the soil, and if the soil is not tilled or trampled when wet. Legumes generally respond to applications of phosphate, and all crops respond to applications of nitrogen.

Furrow irrigation is well suited to row crops, and the border or corrugation methods are suitable for small

grain, alfalfa, and pasture. Sprinklers can be used satisfactorily.

Drainage, control of water table depth, and reduction of salt are important management concerns. Both tile and open drains can be used to remove excess water and salt from the soil. Studies need to be made of the design and layout of drains if they are to be located properly and used effectively. Lining ditches and canals reduces seepage losses. Proper control of irrigation water prevents overirrigation and reduces the salt content of the soil. Land leveling facilitates the uniform distribution of irrigation water. Only enough irrigation water should be applied to satisfy crop needs, although an occasional large application may be required to maintain a favorable salt balance.

CAPABILITY UNIT IVe-2 IRRIGATED

This capability unit consists of deep, well-drained and somewhat excessively drained soils on alluvial fans and plains. These soils are in the Arapien, Genola, and Rapho series. The surface layer ranges from loam to fine sandy loam or gravelly fine sandy loam, and the underlying layers range from loam or light clay loam to gravelly sandy loam.

Slopes range from 5 to 10 percent. The average annual precipitation ranges from 8 to 12 inches, and the frost-free period is 110 to 130 days.

Permeability ranges from moderate to rapid. Runoff is medium to rapid, and the hazard of erosion is severe. The available water capacity ranges from 5 to 11 inches. The effective root zone is about 60 inches or more.

The soils in this capability unit are used for irrigated grass and legumes grown for hay or pasture and small grain. A suitable rotation is 6 to 8 years of alfalfa and grass followed by 1 or 2 years of small grain before seeding back to grass and alfalfa.

The grasses generally respond to annual applications of nitrogen, and legumes respond to applications of phosphate every 3 or 4 years.

Controlled flooding from close-spaced contour ditches is a suitable method of irrigation for alfalfa and grass. Sprinklers can also be used satisfactorily. Small heads of water must be used to control soil losses. To minimize soil loss in cutting irrigation ditches, drop structures should be installed.

CAPABILITY UNIT IVe-UZ NONIRRIGATED

This capability unit consists of deep, well-drained soils on alluvial fans, flood plains, and valley bottoms. These soils are in the Arapien, Birdow, Calita, Doyce, Keigley, Moroni, and Wales series. The surface layer and the underlying layers are generally silt loam, loam, or silty clay loam but range from very fine sandy loam to clay or silty clay. The Atepic soil in the Moroni-Atepic complex is a shaly silty clay loam that is 10 to 20 inches deep over shale.

Slopes range from 2 to 30 percent. The average annual precipitation ranges from 12 to 14 inches, and the frost-free period is 100 to 130 days.

Permeability ranges from slow to moderate. Runoff is slow to rapid, and the hazard of erosion is slight to severe. The water-supplying capacity is 8 to 9 inches

annually. The effective root zone is about 60 inches or more in all except Atepic soils.

The soils in this capability unit are used for non-irrigated grass or small grain. Because precipitation is inadequate, small grain production is low. Erosion is controlled and the soil organic-matter content, tilth, and good water intake are maintained if grass is grown most of the time.

CAPABILITY UNIT IVe-24 IRRIGATED

This capability unit consists of deep, well-drained to excessively drained soils on alluvial fans. These soils are in the Bezzant, Birdow, Collard, Sanpete, and Sigurd series. The surface layer and the underlying layers are cobbly or gravelly or very gravelly or very cobbly loam, sandy loam, or sandy clay loam, except in the Birdow soil, which is silt loam overwashed by loose, fluffy material derived from travertine rock.

Slopes are mostly 1 to 8 percent but range to 25 percent for the Bezzant soil. The average annual precipitation ranges from 8 to 14 inches, and the frost-free period is 110 to 130 days. The Bezzant soil, however, receives 16 inches of precipitation and has 70 to 90 frost-free days.

Permeability ranges from moderate to rapid. Runoff is medium, and the hazard of erosion is slight to severe. The available water capacity is 2 to 8 inches, except in the Birdow soil where it is 8 to 10 inches. The effective root zone is 60 inches or more.

The soils in this capability unit are used mainly for irrigated grass and alfalfa grown for hay or pasture and small grain. A suitable rotation is 6 to 8 years of alfalfa and grass followed by 1 or 2 years of small grain.

The grasses and small grain generally respond to annual applications of nitrogen, and legumes respond to applications of phosphate every 3 or 4 years.

Corrugation and controlled flooding from contour ditches are suitable methods of irrigation for alfalfa, pasture, and small grain. Sprinklers can also be used. Small heads of water must be used, especially when establishing a crop, to keep soil losses to a minimum. Smoothing and shaping the surface is usually not practical because it is covered by gravel and cobbles.

CAPABILITY UNIT Vw-2 NONIRRIGATED

This capability unit consists of deep, poorly drained or very poorly drained soils on valley bottoms and flood plains. These soils are in the Abcal, Canburn, Chipman, Peteetneet, Poganeab, and Shumway series and Poganeab variant. The surface layer ranges from silt loam to silty clay loam, and the underlying layers range from silt loam to silty clay, except for the Peteetneet soil, which has a surface layer of peat.

Slopes range from 0 to 3 percent. The average annual precipitation ranges from 9 to 14 inches, and the frost-free period is generally 100 to 130 days. The Canburn soil is in the mountain valleys near Milburn and Indianola where the frost-free period is less than 100 days.

Permeability ranges from slow to moderate. Runoff is slow or very slow, and the hazard of erosion is none to slight. The available water capacity ranges from 8 to 12 inches. The effective root zone is 60 inches or

more. The water table fluctuates from the surface to a depth of 60 inches. Water frequently ponds on the surface of the Peteetneet soil in spring.

The soils in this capability unit are in meadow used for pasture or hay. They are also used by upland game birds, ducks, and geese as nesting areas. These soils can be fertilized and managed to increase plant vigor, thus encouraging the more desirable plants to dominate the plant community. Some meadow areas can be seeded to adapted grasses and clover.

CAPABILITY UNIT VIe-H NONIRRIGATED

This capability unit consists of deep, well-drained soils on high mountainsides. These soils are in the Gothic, Pritchett, Skylick, Toze, and Zeesix series. The surface layer is silt loam, gravelly silt loam, stony silt loam, or stony loam.

Slopes range from 4 to 40 percent. The average annual precipitation ranges from 24 to 35 inches, and the frost-free period is 70 to 90 days.

Permeability is slow to moderately slow. Runoff is medium, and the hazard of erosion ranges from slight to moderate. The water-supplying capacity ranges from 14 to 20 inches. The effective root zone is 60 inches or more.

The soils in this capability unit are used as summer range by sheep, cattle, deer, and elk. Vegetation is aspen, maple, perennial grasses, and some conifers. The soils are valuable water catchment areas for watersheds. The Pritchett and Skylick soils are also used for aspen woodland.

To minimize soil erosion, grazing must be carefully managed. In areas where the native grasses are depleted, grass can be seeded to provide additional forage and control erosion.

CAPABILITY UNIT VIe-M NONIRRIGATED

This capability unit consists of deep, well-drained soils on mountainsides. These soils are in the Ant Flat, Deer Creek, Harkers, Mower, Obrast, and Watkins Ridge series. The surface layer is mainly stony silt loam, stony loam, silt loam, and silty clay but includes very stony loam.

Slopes range from 4 to 50 percent. The average annual precipitation ranges from 16 to 24 inches, and the frost-free period is 80 to 110 days.

Permeability is very slow to moderately rapid. Runoff is medium, and the hazard of erosion ranges from slight to severe. The water-supplying capacity ranges mainly from 9 to 14 inches. The effective root zone is 40 to 60 inches.

The soils in this capability unit are used as summer range by sheep, cattle, deer, and elk. Vegetation is oakbrush, big sagebrush, and perennial grasses. Grazing must be controlled to minimize soil erosion. Some of these soils are also used as water catchment areas for watersheds.

In areas where the native grasses are depleted, adapted grasses can be seeded in properly prepared seedbeds in which the sagebrush has been plowed up or removed by chaining. Seeding provides additional forage and controls erosion. Where big sagebrush has increased and a fair understory of desirable grasses remains, chemical spraying or controlled burning is

feasible. At least 2 years of non-use after treatment is desirable to permit the grasses to become reestablished.

CAPABILITY UNIT VIe-S NONIRRIGATED

This capability unit consists of deep, well-drained soils on alluvial fans and plains. These soils are in the Amtoft, Crestline, Freedom, Mellor, and Quaker series. The surface layer is mostly fine sandy loam, silt loam, or silty clay loam but also includes flaggy loam.

Slopes range from 2 to 30 percent. The average annual precipitation ranges from 8 to 12 inches, and the frost-free period is 100 to 130 days.

Permeability is moderately slow to moderately rapid. Runoff is medium, and the hazard of erosion is moderate to severe. The water-supplying capacity ranges from 5 to 9 inches. The effective root zone is 60 inches or more, except in the shallow Amtoft soil.

The soils in this capability unit are used as spring and fall range by sheep and cattle. Vegetation is big sagebrush, bitterbrush, and perennial grasses. Grazing must be managed to maintain existing vegetation and minimize soil losses. Some successful seedings of crested wheatgrass have been made during years of above-normal precipitation on well-prepared seedbeds.

CAPABILITY UNIT VIe-U NONIRRIGATED

This capability unit consists of deep, well-drained soils on alluvial fans and mountainsides. These soils are in the Deer Creek and Snake Hollow series. The surface layer is stony silt loam or gravelly fine sandy loam.

Slopes range from 2 to 30 percent. Precipitation ranges from 12 to 14 inches, and the frost-free period is 80 to 110 days.

Permeability is slow to moderately rapid. Runoff is medium, and the hazard of erosion is slight to moderate. The water-supplying capacity ranges from 7 to 11 inches, and the effective root zone is 60 inches or more.

The soils in this capability unit are used as spring and fall range by sheep and cattle and as winter range by deer. Vegetation is big sagebrush, juniper, and Indian ricegrass. Grazing must be managed to maintain the vegetative cover and minimize soil erosion.

Where the native grasses are depleted, adapted grass can be successfully seeded in seedbeds properly prepared by plowing up the sagebrush or chaining the juniper and sagebrush. Seeding provides additional forage and controls soil erosion. In areas where big sagebrush has increased but a fair understory of desirable grasses remain, chemical spraying or controlled burning may be feasible. Grazing should be deferred for 2 years after treatment to allow grasses of good vigor to become reestablished.

CAPABILITY UNIT VIw-2 NONIRRIGATED

This capability unit consists of deep, somewhat poorly drained soils and wet phases of moderately well drained soils on valley bottoms and the low parts of alluvial fans and flood plains. These soils are in the Arapien, Beek, Ephraim, and Green River series. The surface layer is fine sandy loam, loam, or silty clay loam.

Slopes range from 0 to 3 percent. The average annual precipitation ranges from 8 to 14 inches, and the frost-free period is 110 to 130 days.

Permeability is moderately slow to moderate. Runoff is slow, and the hazard of erosion is slight. The effective root zone is 60 inches or more. The depth to the seasonal water table ranges from 20 to 60 inches or more.

The soils in this capability unit are used for native or seeded grass hay or pasture. They can be seeded, fertilized, and managed to improve the composition and quality of forage. They are also used as habitat by upland game birds and waterfowl.

CAPABILITY UNIT VI₆-M NONIRRIGATED

This capability unit consists of shallow to deep, well-drained to somewhat excessively drained soils on mountainsides. These soils are in the Clegg, Lizzant, Lundy, Mountainville, Mower, Sedwell, and Yeates Hollow series. The surface layer is loam or silt loam or stony, very stony, channery, or very cobbly loam, silt loam, or clay loam.

Slopes range from 3 to 40 percent. The average annual precipitation ranges mainly from 16 to 24 inches, and the frost-free period is 70 to 100 days.

Permeability ranges from slow to rapid. Runoff is medium, and the hazard of erosion is slight to moderate. The water-supplying capacity ranges from 5 to 13 inches. The effective root zone is 60 inches or more, except in the Lundy soil where bedrock is at a depth of 10 to 20 inches.

The soils in this capability unit are used as summer range by sheep, cattle, deer, and elk. Vegetation is oakbrush, big sagebrush, bluebunch wheatgrass, and snowberry. Some of the soils are water catchment areas for watersheds. In areas where big sagebrush has increased but a fair understory of desirable grasses remains, chemical spraying or controlled burning may be feasible. Two years of non-use after treatment is desirable to allow the grasses to regain good vigor. Oakbrush areas can be improved and maintained by controlled grazing.

CAPABILITY UNIT VI₆-U NONIRRIGATED

This capability unit consists of moderately deep to deep, well-drained to excessively drained soils on alluvial fans, foothills, and mountainsides. These are soils in the Ant Flat, Bezzant, Borvant, Collard, Donnardo, Doyce, Fontreen, Pavant, and Sanpitch series. Also in this unit are soils of the Sanpitch and Mountainville variants. The surface layer ranges from loam or clay loam to gravelly, stony, cobbly, or very stony fine sandy loam, sandy loam, loam, or clay loam. The Mountainville variant has an indurated lime hardpan at a depth of about 23 inches.

Slopes range from 2 to 40 percent. The average annual precipitation ranges from 12 to 16 inches, and the frost-free period is 80 to 120 days.

Permeability is slow to rapid. Runoff is medium, and the hazard of erosion is slight to moderate. The water-supplying capacity ranges mainly from 6 to 9 inches annually. The effective root zone in the Bagard, Bezzant, Collard, Donnardo, and Fontreen soils is 60 inches or more. In the Borvant, Mountainville variant, and

Pavant soils it is restricted by an indurated lime hardpan between depths of 10 and 40 inches.

The soils in this capability unit are used as spring and fall range by sheep and cattle and as winter range by deer and elk. Some areas are used for juniper and pinon woodland. The juniper is used for fenceposts, and the juniper and pinon are used for firewood. Vegetation is juniper, pinon, big sagebrush, Indian ricegrass, and scattered oakbrush.

In areas where the juniper and pinon have increased, chaining to remove juniper and pinon may be desirable. In areas that have a fair understory of desirable grasses remaining, proper management increases forage production. In areas where the native grasses are depleted, reseeding is needed to increase forage production. In areas where big sagebrush has increased and a fair understory of desirable grasses remain, chemical spraying or controlled burning is feasible. Grazing should be delayed for 2 or 3 years after treatment for the grasses to regain good vigor and seedlings to become established.

CAPABILITY UNIT VII₆-H NONIRRIGATED

This capability unit consists of deep, well-drained and somewhat excessively drained soils on mountainsides. These are Adel, Daybell, Pritchett, and Skylick soils and Cryoborolls. The surface layer is silt loam, gravelly silt loam, or stony fine sandy loam.

Slopes range from 30 to 80 percent. The average annual precipitation ranges from 24 to 35 inches, and the frost-free period is 70 to 90 days.

Permeability is slow to rapid. Runoff is medium, and the hazard of erosion ranges from moderate to severe. The water-supplying capacity is mainly 12 to 20 inches annually. The effective root zone is 60 inches or more.

The soils in this capability unit are used mostly as summer range by sheep, cattle, deer, and elk. The Daybell and Skylick soils are also used for aspen woodland that has an understory of grasses and forbs. Vegetation on the Adel soils is mainly grasses, brackenfern, western coneflower, and aspen. Oakbrush and scattered aspen and conifer dominate the Pritchett soils. Soils in this unit are also used as water catchment areas for watersheds. Reseeding of grasses and clearing of brush or other mechanical practices are not feasible because of the steepness and rough terrain. Grazing must be managed carefully to maintain the existing vegetative cover and minimize soil erosion.

CAPABILITY UNIT VII₆-S NONIRRIGATED

This capability unit consists of deep, well-drained to somewhat excessively drained soils on alluvial fans, alluvial plains, and flood plains. These soils are in the Arapien, Billings, Centerfield, Genola, Linoyer, Lisade, Mayfield, Quaker, Rapho, Ravola, Sanpete, Wales, and Woodrow series. The surface layer ranges from fine sandy loam, very fine sandy loam, gravelly fine sandy loam, very gravelly sandy loam, loam, or shaly loam, to silty clay loam.

Slopes range from 0 to 10 percent. The average annual precipitation ranges from 8 to 12 inches, and the frost-free period is 110 to 130 days.

Permeability ranges from slow to rapid. Runoff is slow to rapid, and the hazard of erosion is slight to

severe. The water-supplying capacity ranges from 5 to 7 inches annually. The effective root zone is mostly 60 inches or more.

The soils in this capability unit are used as winter and spring range by sheep and cattle. Vegetation is mainly shadscale, yellowbrush, and Indian ricegrass. Grazing must be controlled to maintain existing vegetation and minimize soil losses. Range seeding is not practical because precipitation is inadequate.

CAPABILITY UNIT VIIw-28 NONIRRIGATED

This capability unit consists of very poorly drained, somewhat poorly drained, and wet phases of moderately well drained saline-alkali affected soils on valley bottoms. These soils are in the Abcal, Arapien, Cache, Dyreng, Kjar, and Poganeab series. The surface layer ranges from fine sandy loam to silty clay.

Slopes range from 0 to 3 percent. Precipitation ranges from 8 to 12 inches, and the frost-free period is 110 to 130 days.

Permeability ranges from slow to moderate. Runoff is ponded or slow, and the hazard of erosion is none to slight. Depth to the seasonal water table ranges from the surface to 60 inches. The effective root zone is 60 inches or more, but in most soils roots are influenced by the water table below a depth of 30 inches.

The soils in this unit are used mainly for native grass pasture. They are also used as a nesting area and habitat by upland game birds. The salinity of these soils makes them unsuitable for reseeding. Vegetation is mainly saltgrass, wiregrass, bassia, and kochia.

CAPABILITY UNIT VIIb-HC NONIRRIGATED

This capability unit consists of deep, somewhat excessively drained to well-drained soils on mountainsides. These are soils in the Flygare, Kitchell, and Mortenson series and the Mortenson variant. The surface layer is silt loam, fine sandy loam, gravelly loam, or gravelly silt loam.

Slopes mainly range from 40 to 80 percent but are as low as 8 percent in the Mortenson variant. The average annual precipitation ranges from 24 to 35 inches, and the frost-free period is 70 to 90 days.

Permeability is slow to moderately rapid. Runoff is slow to medium, and the hazard of erosion is slight to moderate. The water-supplying capacity ranges from 9 to 20 inches annually. The effective root zone is 60 inches or more, except in the shallow Mortenson variant. Shale between depths of 40 and 60 inches inhibits root penetration.

These soils are used for Douglas-fir, concolor fir, spruce, and aspen woodland. They are also used as summer range by deer and elk.

CAPABILITY UNIT VIIb-M NONIRRIGATED

This capability unit consists of shallow to deep, somewhat excessively drained to well-drained soils on mountainsides. These are soils in the Cheadle, Lizzant, Mower, Tingey, and Wallsburg series and Rock outcrop. The surface layer is mostly stony, very stony, or very flaggy loam or silt loam.

Slopes range from 20 to 70 percent. The average annual precipitation ranges from 16 to 24 inches, and the frost-free period is 70 to 110 days.

Permeability is moderately slow to rapid. Runoff is medium to rapid, and the hazard of erosion is moderate to severe. The water-supplying capacity is 10 to 15 inches annually, except in Cheadle and Wallsburg soils, where it is 6 to 7 inches. The effective root zone is about 60 inches in the Tingey and Lizzant soils; 30 to 40 inches in the Mower soils; and 10 to 20 inches in the Cheadle and Wallsburg soils. It is limited by bedrock.

The soils in this capability unit are used as summer range by sheep, cattle, deer, and elk. Vegetation is mainly oakbrush, big sagebrush, and perennial grasses. Reseeding of grasses and clearing of brush or other mechanical range improvement practices are not feasible because of the steep slopes, rough terrain, and stony or flaggy surface layer.

CAPABILITY UNIT VIIb-S NONIRRIGATED

This capability unit consists of shallow to deep, well-drained and somewhat excessively drained soils on alluvial fans and foothills. These are soils in the Amtoft, Denmark, Sanpete, and Sigurd series, the Atepic variant, Shaly colluvial land, and Torrifluvents and Torriorthents, stony. The surface layer is clay or gravelly, flaggy, cobbly, or stony fine sandy loam or loam. Depth to bedrock ranges from 10 to 60 inches or more.

Slopes range from 1 to 60 percent. The average annual precipitation ranges from 8 to 13 inches, and the frost-free period is 100 to 130 days.

Permeability ranges from slow to rapid. Runoff is medium to rapid, and the hazard of erosion is moderate to very severe. The water-supplying capacity ranges from 3 to 6 inches annually. The effective root zone is 10 to 20 inches in the Amtoft, Atepic, and Denmark soils; few to 36 inches in Shaly colluvial land; and 60 inches or more in the other soils.

The soils in this capability unit are used as winter and spring range by sheep and cattle. Vegetation is mainly shadscale, yellowbrush, and Indian ricegrass. Grass seedings are not successful because precipitation is inadequate, poorly distributed, and occurs at the wrong time.

CAPABILITY UNIT VIIb-S8 NONIRRIGATED

This capability unit consists of well-drained, saline-alkali affected soils on lake terraces, flood plains, and alluvial fans. These soils are in the Genola, Harding, Manassa, Mellor, Quaker, and Skumpah series. The surface layers are loam, silt loam, or silty clay loam.

Slopes range from 0 to 5 percent. The average annual precipitation ranges from 8 to 12 inches, and the frost-free period is 115 to 130 days.

Permeability ranges from slow to moderate. Runoff is slow to rapid, and the hazard of erosion is moderate to severe. The water-supplying capacity range from 3 to 6 inches annually. The effective root zone is 60 inches or more.

The soils in this capability unit are used as winter and spring range by sheep and cattle. They are also used as habitat by upland game birds and rabbits. Because these soils are strongly saline affected, they are not suitable for seeding or other practices intended to

increase the quality or quantity of forage. Vegetation is mainly greasewood, shadscale, and squirreltail grass.

CAPABILITY UNIT VIII-U NONIRRIGATED

This capability unit consists of shallow to deep, well-drained to somewhat excessively drained soils on mountainsides, foothills, and alluvial fans. These are soils in the Atepic, Bagard, Borvant, Donnardo, Doyce, Fontreen, Lodar, Mountainville, Pavant, and Sanpitch series, and Atepic variant, and Rock outcrop. The surface layer ranges from cobbly loam or shaly loam to very cobbly silty clay loam, very cobbly loam, very channery loam, or very gravelly loam. Some of the Donnardo soils have boulders on the surface.

Slopes range from 4 to 70 percent. The average annual precipitation ranges from 12 to 16 inches, and the frost-free period is 90 to 120 days.

Permeability ranges from slow to rapid. Runoff is medium to rapid, and the hazard of erosion is moderate to severe. The water-supplying capacity ranges from 3 to 8 inches annually. The effective root zone is 10 to 20 inches in the Atepic and Lodar soils and is 60 inches or more in the Donnardo and Fontreen soils.

The soils in this capability unit are used as spring and fall range by sheep, cattle, and deer. Vegetation is dominantly juniper, big sagebrush, and perennial grasses. Grass seedings are not successful on these shallow, droughty, and bouldery soils that have low available water capacity and steep slopes. Chaining to remove the juniper, broadcasting the seed, and then covering the seed by chaining in the opposite direction have been successful on some of these soils.

CAPABILITY UNIT VIII-E NONIRRIGATED

This capability unit consists only of Gullied land and Badland. It has a high potential for silt production as a result of runoff and little potential for the production of vegetation. This unit is used mainly as habitat by wildlife and for esthetic purposes.

CAPABILITY UNIT VIII-X NONIRRIGATED

This capability unit consists of deep, well-drained to somewhat excessively drained soils on very steep mountainsides. These are soils in the Bezzant, Bradshaw, Gappmayer, and Tingey series and Rock outcrop. The surface layer and the underlying layers range from stony, very stony, or very cobbly loam to stony, very stony, or very cobbly sandy clay loam.

Slopes are 60 to 80 percent. The average annual precipitation ranges from 18 to 25 inches, and the frost-free period is 70 to 100 days.

Permeability ranges from moderately slow to rapid. Runoff is medium to rapid, and the hazard of erosion is moderate to severe. The water-supplying capacity ranges from 7 to 16 inches annually. The effective root zone is 60 inches or more.

The soils in this capability unit are used as summer range by deer and elk. The terrain is too steep and too rough for cattle and sheep. Vegetation must be protected from overgrazing by wildlife to minimize erosion. These soils are also used as water catchment areas for watersheds and for esthetic purposes.

CAPABILITY UNIT VIII-X NONIRRIGATED

This capability unit consists of bare, steep ledges of Rock land that has a thin mantle of soil on the surface in places. It is used as habitat by wildlife, as water catchment areas for watersheds, and for esthetic purposes.

Predicted yields

The yield estimates in this report are based on yields experienced by farmers. This information was collected by the local soil conservationists and soil scientists. If no information could be obtained for a particular soil, estimates were based on yields from similar soils.

Table 2 presents the predicted yields of the principal crops grown in the survey area. These crops are irrigated alfalfa, wheat, barley, pasture, and corn silage and nonirrigated alfalfa and wheat. The yield estimates for irrigated soils are based on a generalized cropping sequence of legumes, small grain, row crops, and alfalfa seeded with a small grain companion crop. The basic sequence is followed in most of the survey area. Only soils that are suitable for the crops and pasture specified are listed in table 2. In a given year, yields may be considerably higher or lower than the estimated average.

The yield data for alfalfa are based on two full cuttings and a partial third cutting, except in the northern part of the survey area, where they are based on only two cuttings.

The yields are those that can be expected under a moderately high level of management. This management provides applications of phosphorus when alfalfa is seeded and again after 2 or 3 years. Applications of nitrogen are used on row crops and small grain. Animal manure, when available, is mixed with the soil and facilitates good soil tilth. Minimal tillage at the correct moisture content is necessary to prevent soil compaction and formation of tillage pans. Installing control structures on irrigation laterals, land leveling, adjusting lengths of runs to soil conditions, and applying water in accordance with crop requirements are all necessary for efficient use of irrigation water. General crop rotations are followed and weeds controlled.

A moderately high level of management for pastures includes rotation grazing, clipping to control wolf plants and weeds, spreading animal droppings, and applying nitrogen once or twice a year and phosphorus every 2 or 3 years. Pasture is not grazed if the soil is wet and susceptible to packing. Spring grazing begins only if the plants are 8 to 10 inches tall. Four inches of plant growth is left in fall.

A wheat-fallow or wheat-fallow-alfalfa rotation system is used on nonirrigated cropland. When the wheat-fallow-alfalfa system is used, several years of alfalfa are followed by about 4 years of wheat-fallow. Management practices include the use of stubble mulch, rod weeding, fall drilling, and cross slope tillage. Insects and rodents are controlled by crop rotation systems and by acceptable chemicals.

TABLE 2.—*Predicted annual yield per acre of principal crops*
 [Absence of yield indicates that the crop is not generally grown on the soil]

Soil	Irrigated					Nonirrigated	
	Alfalfa	Wheat	Barley	Corn silage	Pasture	Wheat	Alfalfa
	Tons	Bu	Bu	Tons	AUM ¹	Bu	Tons
Anco silty clay loam.....	5.5		95	20	12		
Ant Flat loam, low rainfall, 4 to 8 percent slopes.....						25	2
Arapien fine sandy loam, 1 to 2 percent slopes.....	5.0	55	75	23	10		
Arapien fine sandy loam, 2 to 5 percent slopes, eroded.....	4.5	50	65		9		
Arapien fine sandy loam, 5 to 10 percent slopes, eroded.....	4.5		60		8		
Arapien fine sandy loam, wet, 1 to 2 percent slopes.....	5.0		80		7		
Arapien clay loam, gravelly subsoil, 2 to 5 percent slopes, eroded.....	5.0		75		9		
Arapien cobbly loam, high rainfall, 4 to 15 percent slopes. (Arapien part of unit ARD.).....						15	
Beek silty clay loam.....	5.5		95		12		
Bezzant cobbly loam, 4 to 25 percent slopes.....	4.0				5		
Billings silty clay loam.....	5.0	55	75		8		
Birdow very fine sandy loam, 2 to 4 percent slopes.....	5.5	50	95		12	17	
Birdow very fine sandy loam, 4 to 8 percent slopes.....	4.5	55	75		9	17	
Birdow silt loam, 2 to 4 percent slopes.....	4.0		50		5		
Calita loam, 2 to 4 percent slopes.....	5.0	55	75		11	17	
Calita loam, 4 to 8 percent slopes.....	4.5	40	65		9	17	
Centerfield silty clay loam, 1 to 2 percent slopes.....	5.0	50	70		11		
Centerfield silty clay loam, 2 to 5 percent slopes, eroded.....	4.5	40	65		9		
Clegg loam, 3 to 10 percent slopes.....						25	2
Collard gravelly sandy loam, 4 to 8 percent slopes.....	4.0		55		9		
Doyce loam, 2 to 4 percent slopes.....	5.0	50	75	20	11	17	
Doyce loam, 4 to 8 percent slopes.....	4.5	45	60		9	17	
Doyce loam, wet, 2 to 4 percent slopes.....	4.5	45	10	20	9	17	
Dyrenge silty clay.....	4.5		90	25	11		
Ephraim silty clay loam.....	5.0		90	20	11		
Genola loam, 0 to 2 percent slopes.....	6.0	70	100	25	12		
Genola loam, 2 to 5 percent slopes, eroded.....	5.5	60	80		11		
Genola loam, 5 to 10 percent slopes, eroded.....	5.0		70		8		
Green River loam.....	5.5	60	90	20	12		
Keigley silty clay loam, 2 to 4 percent slopes.....	5.0	70	100	20	12	22	
Linoyer very fine sandy loam, 1 to 2 percent slopes.....	6.0	70	100	25	12		
Linoyer very fine sandy loam, 2 to 5 percent slopes, eroded.....	5.5	60	80		11		
Lisade loam, 1 to 2 percent slopes.....	5.5	70	80	18	10		
Lisade loam, 2 to 5 percent slopes, eroded.....	5.0	60	60		1		
Manila loam, 3 to 10 percent slopes.....						25	2
Moroni silty clay, 2 to 8 percent slopes.....	4.0	45	75		10	17	
Obrast clay loam, low rainfall, 2 to 8 percent slopes.....						22	1.5
Quaker silty clay loam, 1 to 2 percent slopes.....	6.0	65	95	20	12		
Quaker silty clay loam, 2 to 5 percent slopes.....	6.0	60	90		11		
Rapho gravelly fine sandy loam, 2 to 5 percent slopes.....	4.0	50	60		8		
Rapho gravelly fine sandy loam, 5 to 10 percent slopes.....	4.0		60		8		
Ravola loam, 1 to 2 percent slopes.....	6.0	55	95	20	11		
Ravola loam, 2 to 5 percent slopes.....	5.5	50	85		9		
Sanpete gravelly fine sandy loam, 2 to 5 percent slopes.....	3.0		45		8		
Shumway silty clay loam, drained.....	5.0	60	90		11		
Sigurd gravelly loam, 1 to 5 percent slopes.....	3.0		45		8		
Snake Hollow gravelly fine sandy loam, 2 to 4 percent slopes.....	4.5	50	75		9		
Toehead silt loam, 2 to 4 percent slopes.....	5.0	50	80		11	22	1.5
Toehead silt loam, 4 to 8 percent slopes.....	5.0	50	75		10	22	1.5
Toehead silt loam, thin surface variant, 4 to 20 percent slopes.....						22	1.5
Wales silty clay loam, low rainfall, 0 to 2 percent slopes.....	6.0	70	100	20	11		
Wales silty clay loam, low rainfall, 2 to 5 percent slopes.....	5.5	50	85		9		
Watkins Ridge silt loam, 1 to 6 percent slopes.....	5.0	50	80		11	22	1.5
Woodrow silty clay loam, 0 to 2 percent slopes.....	6.0	75	100	22	12		
Woodrow silty clay loam, 2 to 5 percent slopes, eroded.....	6.0	70	90		9		

¹Animal-unit-month. The number of months in a year that an acre will provide grazing for one cow, steer, or horse or seven sheep or goats without injury to pasture.

Range ²

This section gives information about livestock operations in the Sanpete Valley Area. It groups the soils in range sites. Some mapping units were not placed in a range site, because either they are not suitable for range, or they are not used for this purpose.

Approximately 576,000 acres, or 45 percent of the Sanpete Valley Area, is range. About 23 percent of this area produces aspen, pinon pine, and juniper firewood and juniper posts in addition to range. Range vegetation is principally grasses, grasslike plants, shrubs, and forbs.

The range soils usually have soil or climatic limitations to their use for crops. These soils are very gravelly or cobbly or stony, steep, and contain excessive amounts of saline and alkali salts. They have too high a water table, are in too dry a climate, or are at high elevations where the climate is too cold and the growing season too short for cultivated crops. The soils range in texture from sandy loam to clay and in depth from shallow to deep. Some of the soils have little or no development of horizons and others have very strongly developed horizons.

The range lands are used mainly for spring, summer, and fall grazing. Some areas west of Manti, Ephraim, and Mt. Pleasant and south and west of Gunnison are used for winter grazing. The range is grazed mainly by sheep and beef cattle. Horses and dry dairy stock use small areas to a limited extent. Deer and elk graze the range areas during part of the year. Upland game birds, small birds, and animals find food and cover on the range.

Plants are affected by differences in soil characteristics and by climate. Four different climatic zones and one wet or semi-wet area in the Sanpete Valley Area are described. These differ primarily in amounts of precipitation, available water capacity, average annual temperature, and length of the plant growing period. The four climatic zones are high mountain, mountain, upland, and semi-desert.

HIGH MOUNTAIN CLIMATIC ZONE. In this zone the average annual precipitation ranges from 24 to 35 inches. About 60 percent of the precipitation comes during the plant dormant period. Summer precipitation has little effect on plant growth, because it comes in small insignificant storms. Plant growth generally starts about May 15 and continues until about September 30, when it is stopped by frost. The frost-free period is 70 to 90 days. Elevation ranges from 6,700 to 9,700 feet. The mean annual temperature ranges from 36° to 45° F. The three range sites in this climatic zone are High Mountain Loam, High Mountain Loam (Aspen), and High Mountain Stony Loam (Aspen).

MOUNTAIN CLIMATIC ZONE. In this zone the average annual precipitation ranges from 16 to 24 inches. About 60 percent of the precipitation comes during the plant dormant period and is the most dependable source of water for plant growth. Plant growth begins about

May 1 and continues to July 15 when moisture is depleted and the plants are mature. In some years summer precipitation is sufficient to produce plant regrowth late in summer or early fall. The frost-free period is 70 to 110 days. Elevation ranges from 5,500 to 8,500 feet. The mean annual temperature is 38° to 47° F. The five range sites in this climatic zone are Mountain Clay, Mountain Loam, Mountain Loam (Oak), Mountain Shallow Loam, and Mountain Stony Loam.

UPLAND CLIMATIC ZONE. In this zone the average annual precipitation ranges from 12 to 16 inches. About 60 percent of the precipitation comes during the plant dormant period, and precipitation is the most dependable source of water for plant growth. Plant growth begins about April 15 and continues to about July 1 when moisture is depleted and the plants are mature. In some years summer precipitation is sufficient to produce plant regrowth late in summer and early in fall. The frost-free period is about 80 to 120 days. The mean annual temperature is 42° to 50° F. Elevation ranges from 5,400 to 7,200 feet. The seven range sites in this climatic zone are Upland Clay, Upland Loam, Upland Stony Loam, Upland Shallow Hardpan (Juniper-Pinon), Upland Stony Loam (Juniper-Pinon), Upland Stony Hills (Juniper-Pinon), and Upland Shallow Shale (Juniper-Pinon).

SEMI-DESERT CLIMATIC ZONE. In this zone the average annual precipitation ranges from 8 to 12 inches. About 60 percent of the precipitation comes during the plant dormant period, and precipitation is the most dependable source of water for plant growth. Plant growth begins about April 1 and continues to about June 15 when moisture is depleted. In some years summer precipitation is sufficient to produce plant regrowth late in summer and early in fall. The frost-free period ranges from 110 to 130 days. The mean annual temperature is 45° to 52° F. Elevation ranges from 5,000 to 6,200 feet. The five range sites in this climatic zone are Semi-desert Alkali Flats, Semi-desert Limy Loam, Semi-desert Loam, Semi-desert Shallow Loam, and Semi-desert Stony Loam.

WET AND SEMI-WET AREA (caused by a high water table or run-in water from adjacent soils). These areas are characterized by cold, snowy winters and warm, dry summers. Plants receive moisture from the water table, run-in water from adjacent soils, and from precipitation. In some places soils contain saline and alkali salts. The plant growth period begins about April 15 and continues to about September 15. The frost-free period is 110 to 130 days. The mean annual temperature is 45° to 50° F. Range sites in the wet or semi-wet areas are Alkali Bottoms, Salt Meadows, Semi-wet Meadows, and Wet Meadows.

Range sites and range condition

The many different soils and climates in the Sanpete Valley Area have produced several different kinds of range, which differ in their potential to produce native plants. These different kinds of range are called range sites.

Over the centuries, a mixture of plants well suited to each range site has developed. This group of plants is called the potential, or climax, plant community for

²LAMAR R. MASON, State range conservationist, and A. T. FILLINGIM, range conservationist, assisted in the preparation of this section.

the site. The climax plant community varies slightly from year to year, but the basic kinds and amounts of plants remain stable if they are left undisturbed.

The original mixture of plants suited the soil and climate of the range site so perfectly that other kinds of plants could not move in unless an area was disturbed. So consistent is the relationship between plants, climate, and soils that the climax plant community can be accurately predicted, even on severely disturbed sites, if the soil is identified.

Range conservationists and soil scientists group soils that naturally grow in the same climax plant communities into range sites.

Repeated overuse by grazing animals, excessive burning, or plowing results in changes in the kinds, proportions, or amounts of climax plants in the plant community. The kind or degree of disturbance causes some plants to increase while others decrease. If the disturbance is severe, plants that do not belong in the climax plant community invade. Plant response to grazing depends on the kind of grazing animal, the season of use, and how closely the plant is grazed. If good management follows disturbances, however, the climax plant community is gradually reestablished unless the soils have been seriously eroded.

Range condition is expressed as a comparison of the present plant community with the climax plant community for the range site. The more similar the present plants are to the climax plant mixture, the higher the range condition.

The present range condition provides an index to changes that have taken place in the plant community. More important, however, range condition is a basis for predicting the kinds and amounts of changes in the present plant community that can be expected from management and treatment measures. Thus, the range condition rating indicates the nature of the present plant community, and the climax plant community represents a goal toward which range management may be directed.

Knowledge of both the climax and present plant communities is important in management of range. Such information is the basis for selecting management objectives, designing grazing systems, managing for wildlife, determining potential for recreation, and rating watershed conditions.

Any management objective must provide for a plant cover that adequately protects or improves the soil and water resources and meets the needs of the operator. This usually involves increasing desirable plants and restoring the plant community to a near climax condition. Sometimes, however, a plant cover somewhat below climax level better fits specific grazing needs, provides a better wildlife habitat, or furnishes other benefits while still protecting the soil and water resource. Proper grazing use and deferred-rotation grazing systems are basic to the improvement or maintenance of range vegetation. Excessive grazing permits trees and unpalatable shrubs to dominate the vegetation.

In the following pages, the range sites of the Sanpete Valley Area are described and the climax plants are listed for each site. Plant species most likely to invade are also listed. In addition, an estimate of the

potential annual production of air-dry vegetation is indicated for each site. The soils in each range site may be determined by referring to the "Guide to Mapping Units" at the back of this survey.

ALKALI BOTTOMS RANGE SITE

Soils in this site are moderately well drained to somewhat poorly drained, moderately to strongly saline-alkali. These soils are in the Arapien and Dyreng series. They have a fine sandy loam to silty clay surface layer, and their underlying layer is mainly loam, clay loam, or silty clay. Slope is 0 to 2 percent. The average annual precipitation is 8 to 12 inches. Permeability ranges from slow to moderate. Depth to the seasonal water table ranges from 30 to 40 inches.

The potential plant community consists of salt- and alkali-tolerant plants that are about 80 percent grasses and sedges, 19 percent shrubs, and 1 percent forbs. Approximate species composition is 25 percent saltgrass, 15 percent alkali bluegrass, 10 percent Great Basin wildrye, 10 percent sedges, 5 percent each alkali sacaton, four-wing saltbrush, Gardner saltbush, and greasewood, and 20 percent other grasses and forbs. Some of the plants are not usually used by livestock and big game.

If the site is grazed excessively, greasewood and saltgrass increase and replace the better grasses. Common invaders are cheatgrass, annual weeds, halogeton, snakeweed, and saltcedar. Seedbeds prepared on the site are suited to tall wheatgrass and tall fescue.

Total annual yield of air-dry herbage per acre is approximately 2,500 pounds in favorable years and 1,000 pounds in unfavorable years. About 90 percent of this production is forage for livestock and wildlife.

HIGH MOUNTAIN LOAM RANGE SITE

Well-drained Adel, Gothic, Pritchett, Toze, and Zeesix soils are in this site. These soils have a surface layer of silt loam, gravelly silt loam, stony fine sandy loam, or stony loam and an underlying layer ranging from silt loam or gravelly silt loam to stony or very stony clay. Slope ranges from 4 to 80 percent. The average annual precipitation is 24 to 30 inches. Permeability ranges from slow to moderate. The water-supplying capacity ranges from 14 to 30 inches annually.

The potential plant community consists of about 50 percent grasses, 20 percent forbs, and 30 percent shrubs. Plants that invade the site are annual grasses and forbs.

The approximate species composition, by weight, of the potential plant community is 25 percent slender wheatgrass, 15 percent mountain brome, 5 percent bearded wheatgrass, and 5 percent other grasses; 1 percent lomatium, 2 percent peavine, 1 percent tall larkspur, and 15 percent other forbs; 4 percent big sagebrush, 10 percent oakbrush, 7 percent snowberry, and 10 percent other shrubs.

Oakbrush and some of the forbs and other shrubs are not utilized by livestock and big game.

Total annual yield of air-dry herbage per acre is approximately 2,750 pounds in favorable years and 1,300 pounds in unfavorable years. About 80 percent of this production is forage for livestock and wildlife.

Under excessive grazing, big sagebrush, oakbrush, and annual weeds and grasses become the dominant vegetation on this site. Where vegetation is depleted, improvement can be made by brush control and reseeding.

HIGH MOUNTAIN LOAM (ASPEN) RANGE SITE

Well-drained Pritchett and Skylick soils are in this site. These soils have a surface layer of silt loam and a subsoil ranging from clay loam or clay to very stony clay. Slope ranges from 4 to 70 percent. The average annual precipitation is about 24 to 30 inches. Permeability ranges from slow to moderately slow. The water-supplying capacity ranges from 14 to 24 inches annually.

The potential plant community consists of 40 percent aspen trees and 60 percent understory—35 percent grasses, 20 percent forbs, and 5 percent shrubs. Plants that invade the site are big sagebrush, tarweed, houndstongue, and mullein (fig. 12).

The approximate species composition, by weight, of the potential plant community is 10 percent blue wildrye, 20 percent mountain brome, 3 percent nodding brome, and 7 percent other grasses; 2 percent butterweed, 3 percent edible valerian, 5 percent sweet anise, 2 percent peavine, and 8 percent other forbs; 40 per-

cent aspen and traces of other shrubs. Aspen and some of the forbs are not utilized by livestock and big game.

Total annual yield of air-dry herbage per acre is approximately 5,300 pounds in favorable years and 3,200 pounds in unfavorable years. About 65 percent of this production is forage for livestock and wildlife.

Under excessive grazing, aspen increases and the more desirable grasses and forbs decrease in this site. There is also a rapid increase in shrubs, such as snowberry, elderberry, and rose, and in forbs, such as western coneflower and houndstongue. Where desirable grasses and forbs are depleted or absent, a stand of grass can be established by broadcast seeding of orchardgrass and smooth brome prior to leaf fall.

HIGH MOUNTAIN STONY LOAM (ASPEN) RANGE SITE

Somewhat excessively drained and well-drained Daybell soils and Cryoborolls are in this site. These soils have a surface layer of gravelly or stony silt loam and an underlying layer of gravelly fine or very fine sandy loam. Slope ranges from 10 to 70 percent. The average annual precipitation is about 24 to 30 inches. Permeability is rapid. The water-supplying capacity ranges from 11 to 13 inches annually.

The potential plant community consists of about 35 percent aspen trees and 65 percent understory—about



Figure 12.—High Mountain Loam (Aspen) range site in good to fair condition. The soil is Skylick silt loam.

35 percent grasses, 25 percent forbs, and 5 percent shrubs. Plants that invade this site are houndstongue, sneezeweed, tarweed, and big sagebrush.

The approximate species composition, by weight, of the potential plant community is 5 percent bearded wheatgrass, 13 percent blue wildrye, 3 percent slender wheatgrass, and 15 percent other grasses; 5 percent butterweed, 1 percent geranium, 5 percent peavine, and 11 percent other forbs; 35 percent aspen, 1 percent elderberry, 1 percent snowberry, and 5 percent other shrubs. Aspen and some of the forbs and shrubs are not utilized by livestock and big game.

Total annual yield of air-dry herbage per acre is approximately 2,600 pounds in favorable years and 1,400 pounds in unfavorable years. About 60 percent of this production is forage for livestock and wildlife.

Under excessive grazing, aspen, snowberry, chokecherry, western coneflower, and houndstongue increase on this site. Where desired grasses and forbs are depleted, a stand of grass can be established by broadcast seeding of orchardgrass and smooth brome grass prior to leaf fall.

MOUNTAIN CLAY RANGE SITE

Well-drained Obrast soils are in this site. These soils have a surface layer and underlying layer of silty clay or clay. Slope ranges from 4 to 25 percent. The average annual precipitation is 16 to 20 inches. Permeability is very slow. The water-supplying capacity ranges from 9 to 13 inches annually.

The potential plant community consists of about 90 percent grasses, 5 percent forbs, and 5 percent shrubs. Plants that invade the site are cheatgrass, knotweed, mullein, snakeweed, and some annual forbs.

The approximate species composition, by weight, of the potential plant community is 60 percent slender wheatgrass, 5 percent bluebunch wheatgrass, 8 percent Idaho fescue, 5 percent Great Basin wildrye, 4 percent western wheatgrass, and 10 percent other grasses; 3 percent total forbs; 2 percent bitterbrush, 2 percent serviceberry, and 1 percent other shrubs. Some of the forbs and shrubs are not utilized by livestock and big game.

Total annual yield of air-dry herbage per acre is approximately 2,250 pounds in favorable years and 1,750 pounds in unfavorable years. About 95 percent of this production is forage for livestock and wildlife.

This site is generally gently sloping, is readily accessible to livestock, and has been heavily grazed. Heavy grazing has increased mulesear dock and low sagebrush, and they have become the desirable plants. Chemical spraying to control the mulesear dock and sagebrush is desirable if 10 to 13 percent of the decreaser grasses remain. Applied correctly, chemical spray will not injure the grass. The soils of this site are suitable for grass seeding, which should be done only if the desirable grasses are depleted and improvement cannot be achieved. After either spraying or seeding, it is important to defer grazing until the stand is established or the grass regains good vigor.

MOUNTAIN LOAM RANGE SITE

Well-drained Ant Flat, Clegg, and Watkins Ridge soils are in this site. These soils have a surface layer

of loam, stony loam, clay loam, or stony clay loam and underlying layers ranging from silt loam to clay. Slope ranges from 3 to 30 percent. The average annual precipitation is 16 to 20 inches. Permeability is slow to moderate. The water-supplying capacity ranges from 10 to 14 inches annually.

The potential plant community consists of about 85 percent grasses, 5 percent forbs, and 10 percent shrubs. Plants that invade the site are cheatgrass, sixweeks fescue, houndstongue, and rubber rabbitbrush.

The approximate species composition, by weight, of the potential plant community is 72 percent bluebunch wheatgrass, 1 percent Great Basin wildrye, 5 percent tall native bluegrass, and 7 percent other grasses; 2 percent hawksbeard and 3 percent other forbs, 2 percent big sagebrush, 2 percent snowberry, 2 percent yellowbrush, and 4 percent other shrubs. Yellowbrush and some of the forbs and other shrubs are not utilized by livestock and big game.

Total annual yield of air-dry herbage per acre is approximately 2,750 pounds in favorable years and 1,750 pounds in unfavorable years. About 90 percent of this production is forage for livestock and wildlife.

Under excessive grazing, big sagebrush, cheatgrass, and annual weeds increase and become the dominant vegetation on this site. In places, fires and excessive grazing have caused an increase in yellowbrush and rabbitbrush. Where big sagebrush has increased but at least 10 percent of the desirable grasses remain, chemical spraying or controlled burning of sagebrush is desirable. The soils of this site are suitable for grass seeding, which should be done only if the desirable grasses are depleted and improvement cannot be achieved. After either seeding or brush control, it is important to defer grazing until the stand is established or the grass regains good vigor.

MOUNTAIN LOAM (OAK) RANGE SITE

Well-drained Ant Flat, Deer Creek, Harkers, Manila, Sedwell, and Tingey soils are in this site. These soils have a surface layer of loam, stony or very stony loam, stony silt loam, silt loam, or gravelly silt loam and underlying layers of gravelly or cobbly silt loam, silty clay loam, stony clay loam, clay, or cobbly clay. The Sedwell soils have shale at some depth between 30 and 60 inches. Slope ranges from 3 to 40 percent. The average annual precipitation is 16 to 24 inches. Permeability is slow or moderately slow. The water-supplying capacity ranges from 9 to 16 inches annually.

The potential plant community consists of 65 percent overstory—oakbrush and other mountain shrubs and 35 percent understory—25 percent grasses and 10 percent forbs. Plants that invade the site are cheatgrass, houndstongue, rubber rabbitbrush, juniper, pinon pine, and other forbs.

The approximate species composition, by weight, of the potential plant community is 5 percent bearded wheatgrass, 10 percent bluebunch wheatgrass, and 10 percent other grasses; 2 percent balsamroot, 2 percent daisy, 2 percent peavine, 2 percent goldenrod, and 2 percent other forbs; 5 percent birchleaf mahogany, 37 percent Gambel oak, 3 percent maple, 10 percent snowberry, and 10 percent other shrubs. Some of these

plants, such as daisy, goldenrod, Gambel oak, maple, and other shrubs, are not utilized by livestock and big game.

Total annual yield of air-dry herbage per acre is approximately 2,500 pounds in favorable years and 1,750 pounds in unfavorable years. Approximately 60 percent of this production is forage for livestock and wildlife.

Under excessive grazing or burning, oakbrush and other shrubs increase rapidly on this site. The decrease in grazable plants and increase of oakbrush limits and decreases grazing value. Sheep can graze this site more readily than cattle. The high percentage of browse species provides cover and feed for deer.

Mechanical control of brush is not practical. Chemical brush control is questionable because numerous applications are needed before control is obtained. Where desirable grasses have been eliminated, a stand of grass can be established by broadcast seeding of intermediate wheatgrass and orchardgrass prior to leaf fall.

MOUNTAIN SHALLOW LOAM RANGE SITE

Well-drained to excessively drained Cheadle, Lundy, and Wallsburg soils are in this site. These soils are 10 to 40 inches deep over bedrock. They have a surface layer of very flaggy silt loam, channery silt loam, and very stony loam and underlying layers of very flaggy silt loam, very flaggy clay loam, shaly silty clay loam, and very stony clay. Slope ranges from 5 to 70 percent. The average annual precipitation is 16 to 24 inches. Permeability is moderate to rapid. The water-supplying capacity ranges from 5 to 10 inches annually.

The potential plant community consists of 50 percent grasses, 5 percent forbs, and 45 percent shrubs. Plants that invade the site are cheatgrass, hounds-tongue, knotweed, mulesear dock, juniper, and pinon pine.

The approximate species composition, by weight, of the potential plant community is 30 percent bluebunch wheatgrass, 10 percent Great Basin wildrye, 5 percent tall native bluegrass, and 5 percent other grasses; 3 percent balsamroot and 2 percent other forbs; 3 percent birchleaf mahogany, 10 percent big sagebrush, 20 percent bitterbrush, and 12 percent other shrubs. Some forbs and shrubs are not utilized by livestock and big game.

Total annual yield of air-dry herbage per acre is approximately 1,750 pounds in favorable years and 1,000 pounds in unfavorable years. Approximately 95 percent of this production is forage for livestock and wildlife.

Under excessive grazing, sagebrush, oakbrush, western wheatgrass, and cheatgrass replace desirable grasses and forbs on this site. If the desirable grasses make up 10 percent or more of the vegetation, chemical sprays are used to control big sagebrush.

MOUNTAIN STONY LOAM RANGE SITE

Well-drained to somewhat excessively drained Lizant, Mountainville, Mower, and Yeates Hollow soils are in this site. These soils have a surface layer of clay loam, stony loam, or stony silt loam, very cobbly loam, and very stony loam and underlying layers of

very cobbly loam, very stony sandy clay loam, shaly silty clay loam, and very stony clay. Slope ranges from 4 to 60 percent. The average annual precipitation is 16 to 24 inches. Permeability is slow to rapid. The water-supplying capacity ranges from 6 to 10 inches annually.

The potential plant community consists of 70 percent grasses, 5 percent forbs, and 25 percent shrubs. Plants that invade the site are cheatgrass, juniper, pinon pine, rabbitbrush, and snakeweed.

The approximate species composition, by weight, of the potential plant community is 50 percent bluebunch wheatgrass, 3 percent Great Basin wildrye, and 17 percent other grasses; 1 percent balsamroot, 1 percent hawksbeard, and 3 percent other forbs; 5 percent big sagebrush, 7 percent bitterbrush, 10 percent oakbrush, and 3 percent other shrubs. Oakbrush and some grasses, forbs and other shrubs are not utilized by livestock or big game.

Total annual yield of air-dry herbage per acre is approximately 2,500 pounds in favorable years. Approximately 80 percent of this production is forage for livestock and wildlife.

Under excessive grazing or burning, oakbrush and other shrubs increase rapidly and grazing value of the site decreases. The increase of oakbrush limits accessibility for livestock, especially cattle. The high percentage of browse species provides excellent cover and feed for deer.

Mechanical control of brush is not practical, and chemical control is questionable because of the numerous applications needed. Where desired grasses are depleted or absent, a stand of grass can be established by broadcast seeding of intermediate wheatgrass and orchardgrass prior to leaf fall.

SALT MEADOWS RANGE SITE

Deep, very poorly drained to poorly drained, saline-alkali affected Abcal, Cache, Kjar, and Poganeab soils are in this site. These soils have a surface layer of silt loam or silty clay loam and underlying layers of silt loam, silty clay loam, or silty clay. Kjar soils have a peaty layer on the surface. Slope ranges from 0 to 3 percent. The average annual precipitation is 8 to 12 inches. Permeability ranges from moderate to slow. Depth to seasonal water table ranges from the surface to 60 inches.

The potential plant community consists of 90 percent alkali- and salt-tolerant grasses and 10 percent forbs and shrubs. Plants that invade the site are annual kochia, bassia, povertyweed, and curlycup gumweed.

The approximate species composition, by weight, of the potential plant community is 20 percent alkali bluegrass, 15 percent alkali sacaton, 15 percent wiregrass, 5 percent saltgrass, 15 percent tufted hairgrass, and 20 percent other grasses; 1 percent arrowgrass, 3 percent pickleweed, and 3 percent other forbs; 2 percent greasewood and 1 percent other shrubs. Wiregrass, arrowgrass, and some forbs and shrubs are not utilized by livestock.

Total annual yield of air-dry herbage per acre is approximately 4,000 pounds in favorable years and 2,000 pounds in unfavorable years. Approximately 80

percent of this production is forage for livestock and wildlife.

Under excessive grazing, better forage plants decrease, leaving an almost pure stand of saltgrass. This site is not suitable for grass seeding unless drained. If drained, soils can be prepared and seeded to tall wheatgrass or tall fescue.

SEMI-DESERT ALKALI FLATS RANGE SITE

Deep, well-drained, saline-alkali affected Genola, Harding, Manassa, Mellor, Quaker, and Skumpah soils are in this site. These soils have a surface layer of silt loam, loam, or silty clay loam and underlying layers ranging from loam or silt loam to silty clay. The Skumpah soils have gypsum in the lower layers. Slope ranges from 1 to 5 percent. The average annual precipitation is 8 to 12 inches. Permeability ranges from slow to moderate. The water-supplying capacity is less than 4 inches annually.

The potential plant community consists of about 45 percent grasses, 5 percent forbs, and 50 percent salt- and alkali-tolerant shrubs. Plants that invade the site are foxtail, three-awn grass, annual weeds, and Russian-thistle (fig. 13).

The approximate species composition, by weight, of the potential plant community is 25 percent squirrel-tail, 10 percent western wheatgrass, 5 percent Indian ricegrass, 5 percent Sandberg bluegrass, 2 percent other forbs, 3 percent globemallow, 20 percent

greasewood, 5 percent Gray Molly, 20 percent shadscale, and 5 percent others. Some of these plants, such as Gray Molly and others, are not utilized by livestock and big game.

Total annual yield of air-dry herbage per acre is approximately 1,500 pounds in favorable years and 500 pounds in unfavorable years. Approximately 90 percent of this production is forage for livestock and wildlife.

Under excessive grazing, greasewood becomes the dominant vegetation, and halogeton, povertyweed, Russian-thistle, and annual weeds invade the site. This site is generally not suited to grass seedings because precipitation is inadequate.

SEMI-DESERT LIMY LOAM RANGE SITE

Deep, well-drained and somewhat excessively drained Arapien and Lisade soils are in this site. These soils have a surface layer of fine sandy loam, loam, or clay loam and underlying layers ranging from clay loam to gravelly sandy loam. Slope ranges from 1 to 10 percent. The average annual precipitation is 8 to 12 inches. Permeability is moderate to moderately rapid. The water-supplying capacity is 5 to 8 inches annually.

The potential plant community consists of about 70 percent grasses, 5 percent forbs, and 25 percent shrubs. Plants that invade the site are cheatgrass and annual weeds.



Figure 13.—Semi-desert Alkali Flats range site in excellent condition. The soil is Manassa-Mellor complex.

The approximate species composition, by weight, of the potential plant community is 15 percent bluebunch wheatgrass, 20 percent Indian ricegrass, 15 percent needleandthread, 15 percent squirreltail, and 5 percent western wheatgrass; 2 percent globemallow, and 3 percent other forbs; 10 percent black sagebrush, 5 percent winterfat, 5 percent shadscale, and 5 percent other shrubs. Some of the shrubs are not utilized by livestock and big game.

Total annual yield of air-dry herbage per acre is approximately 950 pounds in favorable years and 400 pounds in unfavorable years. About 95 percent of this production is forage for livestock and wildlife.

This site is not suitable for grass seeding because precipitation is inadequate.

SEMI-DESERT LOAM RANGE SITE

Deep, well-drained and somewhat excessively drained Billings, Centerfield, Crestline, Freedom, Genola, Linoyer, Mayfield, Mellor, Quaker, Rapho, Ravola, Wales, and Woodrow soils are in this site. These soils have a surface layer and underlying layer ranging from fine sandy loam to silty clay loam to gravelly sandy loam or shaly loam. Slope ranges from 1 to 10 percent. The average annual precipitation is 8 to 12 inches. Permeability ranges from slow to rapid. The water-supplying capacity ranges from 4 to 9 inches annually.

The potential plant community consists of about 60 percent grasses, 15 percent forbs, and 25 percent shrubs. Plants that invade the site are cheatgrass, fluffgrass, halogeton, and Russian-thistle.

The approximate species composition, by weight, of the potential plant community is 25 percent bluebunch wheatgrass, 20 percent needleandthread, 7 percent Sandberg bluegrass, 7 percent Thurber's needlegrass, and 2 percent other grasses; 2 percent globemallow, 5 percent balsamroot, 2 percent hawksbeard, and 5 percent other forbs; 8 percent black sagebrush, 2 percent bud sagebrush, 2 percent winterfat, 8 percent big sagebrush, 3 percent snakeweed, and 2 percent other shrubs. Snakeweed and some shrubs are not utilized by livestock and big game.

Total annual yield of air-dry herbage per acre is approximately 1,300 pounds in favorable years and 700 pounds in unfavorable years. Approximately 95 percent of this production is forage for livestock and wildlife.

Under excessive grazing, unpalatable shrubs such as sagebrush, snakeweed, and pricklypear increase, and the more desirable grasses and forbs decrease on this site. This site is suitable for grass seeding at the higher elevations where precipitation is about 12 inches and a good seedbed is prepared. At lower elevations, where the precipitation is 9 to 10 inches, grass seedings are less successful.

SEMI-DESERT SHALLOW LOAM RANGE SITE

Well-drained to somewhat excessively drained soils that are 10 to 20 inches deep over hardpan or bedrock are in this site. These are Amtoft and Denmark soils, the Atepic variant, and Shaly colluvial land. These soils have a surface layer of flaggy loam, very stony loam, gravelly loam, or clay loam, and under-

lying layers of very flaggy loam, shaly loam, gravelly loam, or clay. Slope ranges from 2 to 60 percent. The average annual precipitation is 8 to 12 inches. Permeability ranges from slow to moderately rapid. The water-supplying capacity is 3 to 6 inches annually.

The potential plant community consists of about 60 percent grasses, 5 percent forbs, and 35 percent shrubs. The dominant plant that invades this site is cheatgrass.

The approximate species composition, by weight, of the potential plant community is 30 percent bluebunch wheatgrass, 10 percent Indian ricegrass, 7 percent squirreltail, 10 percent needleandthread, and 3 percent other grasses; 1 percent globemallow and 3 percent other forbs; 10 percent big sagebrush, 15 percent black sagebrush, 2 percent shadscale, 5 percent yellowbrush, 2 percent phlox, and 2 percent other shrubs. Yellowbrush and some other shrubs are not utilized by livestock and big game.

Total annual yield of air-dry herbage per acre is approximately 1,500 pounds in favorable years and 800 pounds in unfavorable years. Approximately 90 percent of this production is forage for livestock and wildlife.

Under excessive grazing, shrubs such as big sagebrush, yellowbrush, shadscale, and rubber rabbitbrush increase and desirable grasses and forbs decrease on this site. Inadequate precipitation makes this range site unsuitable for grass seeding.

SEMI-DESERT STONY LOAM RANGE SITE

Somewhat excessively drained Sanpete and Sigurd soils and Torrifluvents and Torriorthents, stony, are in this site. These soils have a surface layer of gravelly, cobbly or stony loam or fine sandy loam and underlying layers of very gravelly or very cobbly loam or fine sandy loam. Slope ranges from 1 to 30 percent. The average annual precipitation is 8 to 12 inches. Permeability is rapid. The water-supplying capacity is 2 to 6 inches annually.

The potential plant community consists of about 70 percent grasses, 5 percent forbs, and 25 percent shrubs. Plants that invade the site are cheatgrass, annual mustard, Russian-thistle, and juniper (fig. 14).

The approximate species composition, by weight, of the potential plant community is 35 percent bluebunch wheatgrass, 5 percent Sandberg bluegrass, 5 percent Thurber's needlegrass, 20 percent Indian ricegrass, 2 percent squirreltail, and 3 percent other grasses; 2 percent globemallow, 2 percent hawksbeard, and 1 percent other forbs; 10 percent big sagebrush, 5 percent black sagebrush, 5 percent shadscale, 2 percent yellowbrush, and 3 percent other shrubs. Yellowbrush and some other shrubs are not utilized by livestock and big game.

Total annual yield of air-dry herbage per acre is approximately 1,250 pounds in favorable years and 750 pounds in unfavorable years. Approximately 95 percent of this production is forage for livestock and wildlife.

Under excessive grazing, big sagebrush, shadscale, yellowbrush, snakeweed, and squirreltail increase and desirable grasses and forbs decrease on this site. This range site is unsuitable for grass seeding because



Figure 14.—Semi-desert Stony Loam range site in good condition. The soil is Sanpete gravelly fine sandy loam.

precipitation is inadequate or untimely and because the soils are stony, cobbly, or gravelly and have a low water-supplying capacity.

SEMI-WET MEADOWS RANGE SITE

Deep, somewhat poorly drained to moderately well drained Arapien, Beek, Ephraim, and Green River soils and Xerofluvents and Fluvaquents are in this site. These soils have a surface layer of fine sandy loam to loam or silty clay loam and underlying layers ranging from sandy loam to silty clay loam. Slope ranges from 0 to 3 percent. The average annual precipitation is 8 to 12 inches. Permeability is moderately slow to moderate. Depth to the seasonal water table is 20 to 60 inches or more.

The potential plant community consists of about 85 percent grasses, 10 percent forbs, and 5 percent shrubs. Plants that invade the site are annual weeds, big rabbitbrush, big sagebrush, cheatgrass, dandelion, foxtail, and greasewood.

The approximate species composition, by weight, of the potential plant community is 10 percent Great Basin wildrye, 30 percent slender wheatgrass, 10 percent tufted hairgrass, 5 percent alkali sacaton, 5 percent western wheatgrass, 5 percent sedges, and 20 percent other grasslike plants; 10 percent forbs; 1

percent rose, 1 percent shrubby cinquefoil, 1 percent willow, and 2 percent other shrubs. Shrubby cinquefoil, willows, and some other shrubs and forbs are not utilized by livestock and big game.

Total annual yield of air-dry herbage per acre is approximately 4,200 pounds in favorable years and 1,750 pounds in unfavorable years. Approximately 90 percent of this production is forage for livestock and wildlife.

Under excessive grazing, Kentucky bluegrass, big rabbitbrush, and big sagebrush become the dominant plants on this site. This site can be successfully seeded to intermediate wheatgrass and other adapted species.

UPLAND LOAM RANGE SITE

Well-drained soils in the Arapien, Ant Flat, Birdow, Calita, Deer Creek, Doyce, Keigley, Snake Hollow, Toehead, Wales, and Watkins Ridge series and the Toehead variant are in this site. These soils mostly have a surface layer and underlying layers ranging from the fine sandy loam to silty clay loam, gravelly fine sandy loam, or cobbly loam. The Deer Creek soil has a surface layer of stony silt loam and a subsoil of cobbly clay. Ant Flat soil has a subsoil of clay. Slope ranges from 1 to 30 percent. The average annual precipitation is 12 to 16 inches. Permeability ranges from

slow to moderately rapid. The water-supplying capacity is 8 to 13 inches annually.

The potential plant community consists of about 80 percent grasses, 10 percent forbs, and 10 percent shrubs. Plants that invade the site are cheatgrass, gumweed, juniper, snakeweed, and annual weeds.

The approximate species composition, by weight, of the potential plant community is 50 percent bluebunch wheatgrass, 5 percent Great Basin wildrye, 5 percent Indian ricegrass, 3 percent Sandberg bluegrass, 3 percent tall native bluegrass, 3 percent western wheatgrass, and 11 percent other grasses; 2 percent astragalus, 2 percent balsamroot, 2 percent peavine, and 4 percent other forbs; 2 percent big sagebrush, 2 percent bitterbrush, 2 percent winterfat, 2 percent yellowbrush, and 2 percent other shrubs. Astragalus, yellowbrush, and some other forbs and shrubs are not utilized by livestock and big game.

Total annual yield of air-dry herbage per acre is approximately 1,800 pounds in favorable years and 1,400 pounds in unfavorable years. Approximately 90 percent of the production is forage for livestock and wildlife.

Under continuous heavy grazing, big sagebrush, cheatgrass, and annual forbs increase rapidly and the more desirable grasses and forbs decrease. As the range declines, a pure stand of sagebrush with an understory of cheatgrass results. Where big sagebrush has increased but at least 10 percent of the desirable grasses remain, chemical spraying or controlled burning to control the sagebrush is desirable. Neither chemical sprays nor burning will kill the grass if used correctly. The soils of this site are well suited to seedbed preparation and drilling of grass seed. Grass seeding should be done only if all desirable grasses are depleted. After treatment it is important to defer grazing until the stand of grass is established or regains good vigor.

UPLAND CLAY RANGE SITE

Well-drained Moroni and Obrast soils are in this site. These soils have a surface layer of clay loam or silty clay and underlying layers of silty clay or clay. Slope ranges from 2 to 16 percent. The average annual precipitation is about 12 to 16 inches. Permeability is very slow or slow. The water-supplying capacity ranges from 8 to 12 inches annually.

The potential plant community consists of about 85 percent grasses, 5 percent forbs, and 10 percent shrubs. Plants that invade the site are cheatgrass, gumweed, snakeweed, and annual forbs.

The approximate species composition, by weight, of the potential plant community is 50 percent bluebunch wheatgrass, 21 percent Indian ricegrass, 5 percent western wheatgrass, 5 percent needleandthread, and 2 percent other grasses; 1 percent globemallow, 1 percent Drummond thistle, and 1 percent other forbs; 10 percent big sagebrush, 2 percent phlox, 1 percent yellowbrush, and 1 percent other brush. Drummond thistle, phlox, yellowbrush, other brush and some forbs are not utilized by livestock and big game.

Total annual yield of air-dry herbage per acre is approximately 1,500 pounds in favorable years and

900 pounds in unfavorable years. About 95 percent of this production is forage for livestock and wildlife.

Under excessive grazing, big sagebrush, cheatgrass, gumweed, snakeweed, and other annuals increase and the more desirable grasses decrease on this site. In areas where big sagebrush has increased and a fair understory of the desirable grasses remains, chemical spraying or controlled burning of sagebrush is desirable. Neither chemical sprays nor burning will kill the grass if used correctly. This site can also be plowed and drilled for topsoil or crested wheatgrass. After treatment it is important to defer grazing until the stand of grass is established or until it regains good vigor.

UPLAND STONY LOAM RANGE SITE

Well-drained to excessively drained Bezzant, Collard, Donnardo, and Mountainville soils and the Mountainville variant are in this site. These soils have a surface layer of gravelly, bouldery, cobbly, or very stony loam or sandy loam and underlying layers of very gravelly, very cobbly, or very stony loam, sandy clay loam, or clay. The Mountainville variant has a lime-cemented hardpan at a depth between 20 and 40 inches. Slope ranges from 2 to 40 percent. The average annual precipitation is about 12 to 16 inches. Permeability is moderate to rapid, except in the Mountainville variant, where it is slow. The water-supplying capacity ranges from 6 to 10 inches annually.

The potential plant community consists of about 65 percent grasses, 5 percent forbs, and 30 percent shrubs. Plants that invade the site are cheatgrass, juniper, pinon, snakeweed, and annual weeds and forbs.

The approximate species composition, by weight, of the potential plant community is 60 percent bluebunch wheatgrass, 2 percent Indian ricegrass, and 3 percent other grasses; 2 percent balsamroot, 1 percent phlox, and 2 percent other forbs; 5 percent big sagebrush, 5 percent birchleaf mahogany, 2 percent bitterbrush, 5 percent black sagebrush, 10 percent shadscale, and 3 percent other shrubs. Some forbs and shrubs are not utilized by livestock and big game.

Total annual yield of air-dry herbage per acre is approximately 2,300 pounds in favorable years and 1,400 pounds in unfavorable years. About 95 percent of this production is forage for livestock and wildlife.

Under excessive grazing, big sagebrush, cheatgrass, and annual weeds and forbs replace the desirable grasses. Stones and boulders on the surface of these soils make them unsuitable for plowing and drilling for grass seedings. Where big sagebrush has increased and a fair understory of desirable grasses remains, chemical spraying or controlled burning of sagebrush is desirable. Used correctly, neither chemical sprays nor burning will kill the grass. Where desirable grasses are depleted or absent, a stand of grass can be established by broadcast seeding and chaining. After treatment it is important to defer grazing until the stand of grass is established or until it regains good vigor.

UPLAND SHALLOW HARDPAN (JUNIPER-PINON) RANGE SITE

Well-drained and somewhat excessively drained Borvant and Pavant soils are in this site. These soils have a surface layer ranging from loam to cobbly or very

stony loam and an underlying layer ranging from clay loam to very gravelly or very cobbly loam. Slope ranges from 2 to 25 percent. The average annual precipitation is 12 to 14 inches. Permeability ranges from slow to moderately rapid above the hardpan. The water-supplying capacity ranges from 4 to 6 inches annually.

The potential plant community consists of 45 percent juniper and pinon, 35 percent grasses, 5 percent forbs, and 15 percent shrubs. Plants that invade the site are cheatgrass, sixweeks fescue, three-awn grass, halogeton, and snakeweed.

The approximate species composition, by weight, of the potential plant community is 10 percent bluebunch wheatgrass, 15 percent Indian ricegrass, 3 percent needleandthread, 2 percent tall native bluegrass, 2 percent western wheatgrass, and 3 percent other grasses; 2 percent balsamroot, 1 percent globemallow, and 2 percent other forbs; 2 percent big sagebrush, 3 percent bitterbrush, 1 percent black sagebrush, 10 percent pinon pine, 35 percent juniper, and 9 percent other trees and shrubs. The pinon pine and juniper are not utilized by livestock and big game.

Total annual yield of air-dry herbage per acre is approximately 1,500 pounds in favorable years and 900 pounds in unfavorable years. About 55 percent of this production is forage for livestock and wildlife.

Under excessive grazing, a thickened stand of juniper and pinon pine will replace the grasses, forbs, and many shrubs on this site. The shallow stony soils of this site are not suitable for plowing and drilling grass seed. The better forage plants will increase if the juniper and pinon pine are cleared by chaining or bulldozing. Where most of the desirable grasses, forbs, and shrubs are depleted, a stand of grass or other forage can be established by chaining in one direction, broadcasting seed, and then chaining in the opposite direction to cover the seed. The second chaining removes any trees not completely pulled out by the initial chaining.

UPLAND SHALLOW LOAM (JUNIPER-PINON) RANGE SITE

Somewhat excessively drained Lodar soils that are 10 to 20 inches deep over bedrock are in this site. These soils have a surface layer of very channery or very cobbly loam and an underlying layer of very gravelly or very cobbly loam. Slope ranges from 8 to 70 percent. The average annual precipitation is 12 to 14 inches. Permeability is moderately rapid. The water-supplying capacity ranges from 3 to 4½ inches annually.

The potential plant community consists of about 60 percent grasses, 3 percent forbs, 12 percent shrubs, and 25 percent juniper and pinon pine. Plants that invade the site are cheatgrass, three-awn grass, snake-weed, and annual forbs.

The approximate species composition, by weight, of the potential plant community is 45 percent bluebunch wheatgrass, 5 percent needleandthread, 5 percent Sandberg bluegrass, and 5 percent other grasses; 3 percent forbs; 5 percent pinon pine, 20 percent juniper, 5 percent big sagebrush, 2 percent black sagebrush, 1 percent shadscale, and 4 percent other trees and shrubs. The pinon pine, juniper, other trees, and some shrubs are not utilized by livestock and big game.

Total annual yield of air-dry herbage per acre is approximately 1,750 pounds in favorable years and 1,300 pounds in unfavorable years. About 70 percent of this production is forage for livestock and wildlife.

Under excessive grazing, the more desirable grasses and forage are depleted, and the trees and unpalatable shrubs increase on this site. Droughty, shallow, stony, steep conditions make these soils unsuitable for grass seeding.

UPLAND STONY LOAM (JUNIPER-PINON) RANGE SITE

Well-drained to excessively drained Bagard, Collard, Donnardo, Fontreen, and Sanpitch soils and the Sanpitch variant are in this site. These soils have a surface layer of cobbly loam, very cobbly loam, stony sandy loam, very stony loam, and very stony clay loam and an underlying layer of cobbly, gravelly, stony, very cobbly, very gravelly, or very stony loam, sandy clay loam, or clay. The Sanpitch variant lacks coarse fragments in both the surface layer and the subsoil. Slope ranges from 4 to 70 percent. The average annual precipitation is dominantly 12 to 14 inches. Permeability ranges from moderately slow to rapid. The water-supplying capacity ranges from 5 to 10 inches annually.

The potential plant community consists of about 35 percent juniper and pinon pine trees and 65 percent understory—45 percent grasses, 5 percent forbs, and 15 percent shrubs. Plants that invade the site are cheatgrass, three-awn grass, snakeweed, and annual forbs (fig. 15).

The approximate species composition, by weight, of the potential plant community is 35 percent bluebunch wheatgrass, 3 percent Indian ricegrass, 2 percent needleandthread, and 5 percent other grasses; 5 percent forbs; 10 percent black sagebrush, 5 percent pinon pine, 30 percent juniper, and 5 percent other shrubs and trees. The pinon pine and juniper are not utilized by livestock and big game.

Total annual yield of air-dry herbage per acre is approximately 1,350 pounds in favorable years and 1,000 pounds in unfavorable years. About 65 percent of this production is forage for livestock and wildlife.

Under excessive grazing, juniper, pinon pine, big sagebrush, and cheatgrass replace the desirable grasses, forbs, and many shrubs. Soils are too stony to be seeded by plowing and drilling. If slope is less than 40 percent, juniper and pinon pine can be cleared by chaining or bulldozing to allow the more desirable forage species to increase. Where most of the desirable plants are depleted or absent, they can be established by chaining in one direction, then broadcasting the seed and chaining in the opposite direction. The second chaining covers the seed and removes those trees not completely pulled out by the initial chaining.

UPLAND SHALLOW SHALE (JUNIPER-PINON) RANGE SITE

Well-drained Atepic soils that are 10 to 20 inches deep over shale are in this site. These soils have a surface layer of very cobbly silty clay loam or shaly clay loam and an underlying layer of shaly silty clay loam. Slope ranges from 8 to 40 percent. The average annual precipitation is 12 to 15 inches. Permeability is slow. The water-supplying capacity ranges from 4 to 6 inches annually.



Figure 15.—Upland Stony Loam (Juniper-Pinon) range site in good condition. The soil is Fontneen cobbly loam.

The potential plant community consists of an overstory of about 65 percent juniper and pinon pine and an understory of 20 percent grasses, 5 percent forbs, and 10 percent shrubs. Plants that invade this site under heavy use are cheatgrass, snakeweed, and other annual forbs.

The approximate species composition, by weight, of the potential plant community is 10 percent bluebunch wheatgrass, 8 percent Indian ricegrass, and 2 percent other grasses; 2 percent poison vetch, 1 percent astragalus, 1 percent buckwheat, and 1 percent other forbs; 5 percent pinon pine, 60 percent juniper, and 10 percent shrubs. The pinon pine and juniper are not utilized by livestock and big game.

Total annual yield of air-dry herbage per acre is approximately 2,500 pounds in favorable years and 1,500 pounds in unfavorable years. About 35 percent of this production is forage for livestock and wildlife.

Under excessive grazing, juniper, pinon pine, big sagebrush, and cheatgrass replace the grasses, forbs, and many of the shrubs. Shallow, cobbly, highly erodible, and steep conditions make these soils unsuitable for seeding.

WET MEADOWS RANGE SITE

Deep, poorly drained or very poorly drained Abcal, Canburn, Chipman, Peteetneet, Poganeab, and Shum-

way soils, the Poganeab variant, and Fluvaguents are in this site. These soils have a surface layer of silt loam or silty clay loam and underlying layers of silt loam to silty clay. The Peteetneet soil is peaty. Slope ranges from 0 to 3 percent. The average annual precipitation ranges from 8 to 12 inches. Permeability is slow to moderate. The seasonal water table fluctuates from the surface to a depth of 60 inches.

The potential plant community consists of about 95 percent grasses and grasslike plants, 3 percent forbs, and 2 percent shrubs. Plants that invade the site are foxtail, curlycup gumweed, teasel, and rubber rabbitbrush.

The approximate species composition, by weight, of the potential plant community is 20 percent broadleaf sedges, 30 percent tufted hairgrass, 5 percent creeping wildrye, 10 percent wiregrass, 5 percent redtop, 5 percent Kentucky bluegrass, and 20 percent other grasses; 3 percent forbs; and 2 percent shrubs. The forbs and shrubs are not utilized by livestock and big game.

Total annual yield of air-dry herbage per acre is approximately 6,500 pounds in favorable years and 3,500 pounds in unfavorable years. About 95 percent of this production is forage for livestock and wildlife.

Under excessive grazing, the foxtail, saltgrass, Kentucky bluegrass, wiregrass, and sedges increase, and wiregrass is the dominant species in some places.

Fencing into smaller pastures, rotation grazing, applying nitrogen to the soil, and surface drainage improve the condition of the range and the quantity and quality of forage. Seeding to grasses and legume mixtures for better pasture production is feasible when the soils are drained.

Wildlife

Most soils in the Sanpete Valley Areas support vegetation that is used by wildlife. Species of wildlife, however, are not confined to areas of a particular soil or group of soils. The presence of wildlife in a given area depends on available food, water, and cover.

The mountains provide habitat for mule deer. Elk are mainly in the mountains east of the irrigated valleys. These lands are very popular for hunting.

Natural streams in the survey area provide fishing for local residents and tourists. Rainbow, brown, brook, and cutthroat trout reproduce naturally. The supply is supplemented by stocking with pond-reared fish.

Reservoirs and streams provide good duck and goose hunting and habitat for beaver, muskrat, shore birds, and other species that thrive near water. Chukar, mourning dove, quail, pheasant, and sage grouse are popular upland game. Ruffed and blue grouse are in areas canopied by aspen or conifer.

Songbirds are numerous. Black-tailed jackrabbit, bobcat, cottontail rabbit, coyote, porcupine, skunk, snowshoe hare, weasel, and woodchuck also inhabit the area.

Soils directly affect the kind and amount of vegetation available to wildlife as food and cover, and they affect the development of water impoundments. The kind and abundance of wildlife in an area depend largely on the amount and distribution of food, cover, and water. If any one of these elements is missing, inadequate, or inaccessible, wildlife is scarce.

If the soils have the potential, wildlife habitat can be created or improved by planting appropriate vegetation, by properly managing the existing plant cover, and by fostering the natural establishment of desirable plants.

Wildlife suitability groups

The soils in this Area have been grouped into 14 wildlife suitability groups. Each group consists of soils that have similar rating for each of the habitat elements and the same rating for the four kinds of wildlife habitat. Ratings are based on suitability of the soil for improvement, maintenance, or creation of each of the habitat elements and for each kind of wildlife habitat.

In Utah, wildlife suitability groups are designated by a symbol that represents the rating for a kind of wildlife habitat. The first numeral is for openland habitat, the second, woodland habitat, the third, wetland habitat, and the fourth numeral is for rangeland habitat. Number 1 is good; 2 is fair; 3 is poor; and 4 is very poor. For example, wildlife suitability group 3242 is poor for openland, fair for woodland, very poor for wetland, and fair for rangeland. Irrigated wildlife suitability groups have the letter I following the numeral symbol, for example, 2141-I.

Knowing the properties of soils makes possible the prediction of their behavior under specific management practices. Proper management of soils, water, and plants to produce a suitable habitat is the most effective way to maintain and improve wildlife populations.

Table 3 lists the wildlife groups and gives the rating for the habitat elements and the kinds of wildlife habitat for each wildlife suitability group. This information can be used in—

1. Planning parks, wildlife refuges, nature study areas, and other developments for wildlife.
2. Selecting suitable soils for creating, improving, or maintaining specific elements of wildlife habitat.
3. Determining the intensity of management needed for each element of the habitat.
4. Determining suitable areas for wildlife management.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* means that the element of wildlife habitat or the kind of habitat is easily created, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected if the soil is used for the designated purpose. A rating of *fair* means that the element of wildlife habitat or kind of habitat can be created, improved, or maintained in most places. Moderate intensity of management and fairly frequent attention are required for satisfactory results. A rating of *poor* means that limitations are severe for the designated element or kind of wildlife habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and requires intensive effort. A rating of *very poor* means that restrictions for the element of wildlife habitat or kind of wildlife are very severe and unsatisfactory results can be expected. Wildlife habitat is impractical or even impossible to create, improve, or maintain on soils having such a rating.

Dual ratings, such as *good to fair*, indicate that within the suitability group some soils are rated *good* and others only *fair* for the habitat element.

The elements of wildlife habitat are briefly described in the following paragraphs.

Grain and seed crops are seed-producing annuals used by wildlife. Examples are corn, wheat, oats, and barley. The major soil properties that affect grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations.

Grasses and legumes are domestic perennial grasses and herbaceous legumes planted for wildlife food and cover. Examples are fescue, brome grass, timothy, orchardgrass, clover, and alfalfa. Major soil properties that affect grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations.

Wild herbaceous plants are native or naturally established herbaceous grasses and forbs, including weeds, that provide food and cover for wildlife. Examples are bluegrass, brome grass, fescue, Indian rice-

TABLE 3.—*Wildlife suitability groups and ratings for habitat elements and kinds of habitat*

Wild-life suitability group	Potential for habitat elements								Potential as habitat for—			
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hard-wood trees	Coniferous plants	Shrubs	Wet-land plants	Shallow-water develop-ments	Open-land wildlife	Wood-land wildlife	Wet-land wildlife	Range-land wildlife
1141-I.....	Good to fair.	Good to fair.	Good to fair.	-----	Good to fair.	Good to fair.	Very poor.	Very poor.	Good---	Good---	Very poor.	Good.
2121-I.....	Fair-----	Fair-----	Good---	Good---	-----	Good---	Fair---	Fair---	Fair---	Good---	Fair---	Good.
2121.....	Poor-----	Poor-----	Good---	Good---	-----	Good---	Fair---	Fair---	Fair---	Good---	Fair---	Good.
2141-I.....	Fair-----	Fair-----	Good---	Good---	-----	Good---	Very poor.	Very poor.	Fair---	Good---	Very poor.	Good.
2141.....	Poor to fair.	Poor to fair.	Good---	Good---	-----	Good---	Very poor.	Very poor.	Fair---	Good---	Very poor.	Good.
3141.....	Poor to very poor.	Poor to very poor.	Good to fair.	Good to fair.	Good---	Good to fair.	Very poor.	Very poor.	Poor---	Good---	Very poor.	Good.
3212.....	Very poor.	Poor---	Fair---	Fair---	-----	Fair---	Good---	Good---	Poor---	Fair---	Good---	Fair.
3242.....	Poor to very poor.	Poor to very poor.	Fair---	-----	Fair to poor.	Fair---	Very poor.	Very poor.	Poor---	Fair---	Very poor.	Fair.
3242-I.....	Poor---	Poor---	Fair---	-----	Poor---	Fair---	Very poor.	Very poor.	Poor---	Fair---	Very poor.	Fair.
3342.....	Poor to very poor.	Poor---	Fair to poor.	-----	Very poor to poor.	Fair---	Very poor.	Very poor.	Poor---	Poor---	Very poor.	Fair.
4343.....	Very poor to poor.	Very poor to poor.	Poor---	-----	Poor to fair.	Poor---	Very poor.	Very poor.	Very poor.	Poor---	Very poor.	Poor.
4424.....	Very poor.	Very poor.	Poor to very poor.	Very poor.	-----	Very poor.	Fair to poor.	Good---	Very poor.	Very poor.	Fair---	Very poor.
4434.....	Very poor to poor.	Very poor to poor.	Very poor to poor.	-----	Very poor.	Very poor.	Poor---	Very poor to poor.	Very poor.	Very poor.	Poor---	Very poor.
4444.....	Very poor to poor.	Very poor to poor.	Very poor to poor.	-----	Very poor.	Very poor.	Poor---	Very poor to poor.	Very poor.	Very poor.	Very poor.	Very poor.

grass, squirreltail, and wheatgrass. Major soil properties that affect these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations.

Coniferous plants are cone-bearing trees, shrubs, or ground cover that furnish habitat or food in the form of browse, seeds, or fruitlike cones. Examples are pine, spruce, fir, and juniper. Major soil properties that affect coniferous plants are depth of the root zone, available water capacity, and wetness.

Shrubs are brush woody plants that produce fruits, buds, twigs, bark, or foliages used by wildlife or that provide cover and shade for some species. Examples are greasewood, oakbrush, rabbitbrush, shadscale, and big sagebrush. Major soil properties that affect shrubs are depth of the root zone, available water capacity, salinity, and moisture.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites, exclusive of submerged or floating aquatics. They produce food cover for wetland wildlife. Examples of wet-

land plants are smartweed, wild millet, rushes, sedges, reeds, wildrice, saltgrass, cordgrass, and cattail. Major soil properties affecting wetland plants are texture of the surface layer, wetness, reaction, and salinity.

Shallow water areas are bodies of surface water that have an average depth of less than 5 feet. They can be naturally wet areas, such as marshes or streams, or they can be created by dams, levees, or other water-control devices. Examples are muskrat marshes, waterfowl feeding areas, wildlife watering developments, beaver ponds, and other wildlife ponds. Major soil properties affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. A dependable water supply is also important if water areas are to be developed.

The kinds of wildlife habitat are briefly described in the following paragraphs.

Openland habitat consists of croplands, pastures, meadows, and areas overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The kinds of wildlife attracted to these areas are

cottontail rabbit, jack rabbit, coyote, skunk, woodchuck, geese, ringed-necked pheasant, meadowlark, mourning dove, quail, and songbirds.

Wetland habitat consists of water-tolerant plants in open, marshy, or swampy shallow water areas. Examples of wildlife attracted to this habitat are duck, geese, heron, shore birds, rail, kingfisher, muskrat, mink, and beaver.

Rangeland habitat consists of wild herbaceous plants and shrubs on range. Examples of wildlife attracted to this habitat are bobcat, coyote, elk, jackrabbit, mule deer, chukar, quail, sage grouse, and songbirds.

Woodland habitat consists of wooded areas containing either hardwood trees, coniferous trees, understory shrubs, or a mixture of these. Birds and mammals generally common to these areas are blue and ruffed grouse, songbirds, woodpeckers, squirrels, mule deer, elk, and black bear.

WILDLIFE SUITABILITY GROUP 1141-I

The soils in this group are good for openland, woodland, and rangeland wildlife and very poor for wetland wildlife. These soils are deep and well drained or moderately well drained. The surface layer ranges from fine sandy loam to silty clay. Slope ranges from 1 to 10 percent.

The available water capacity ranges from 4 to 12 inches to a depth of 5 feet. Average annual precipitation is 8 to 14 inches. The mean annual temperature is 45° to 51° F., and the frost-free period is 100 to 130 days.

Soils in this group are used for irrigated crops. Crops grown are alfalfa, small grain, pasture, sugar beets, and corn for silage.

WILDLIFE SUITABILITY GROUP 2121-I

The soils in this group are fair for openland wildlife, good for woodland and rangeland wildlife, and fair for wetland wildlife. These irrigated soils are deep and are somewhat poorly drained to moderately well drained. The surface layer ranges from silty clay loam to fine sandy loam. Slope ranges from 1 to 3 percent.

The available water capacity ranges from 6 to 12 inches to a depth of 5 feet. The average annual precipitation is 8 to 14 inches. The mean annual temperature is 45° to 52° F., and the frost-free period is 110 to 130 days.

Soils in this group are used for irrigated crops. Crops grown are alfalfa, pasture, and small grain.

WILDLIFE SUITABILITY GROUP 2121

The soils in this group are fair for openland and wetland wildlife and good for woodland and rangeland wildlife. These nonirrigated soils are deep and are somewhat poorly drained to moderately well drained. The surface layer ranges from silty clay loam to fine sandy loam. Slope ranges from 1 to 3 percent.

The available water capacity ranges from 6 to 12 inches to a depth of 5 feet. The water table fluctuates from the surface to a depth of 60 inches. The average annual precipitation is 8 to 14 inches. The mean annual temperature is 45° to 52° F., and the frost-free period is 110 to 130 days.

Native vegetation consists of Kentucky bluegrass,

rabbitbrush, willows, wiregrass, tules, cattails, salt-grass, and annual weeds.

WILDLIFE SUITABILITY GROUP 2141-I

The soils in this group are fair for openland wildlife, good for woodland and rangeland wildlife, and very poor for wetland wildlife. These irrigated soils are deep and are well drained. The surface layer is silt loam. Slope ranges from 2 to 8 percent.

The available water capacity ranges from 8 to 12 inches to a depth of 5 feet. The average annual precipitation is 14 to 20 inches. The mean annual temperature is 43° to 45° F., and the frost-free period is 80 to 110 days.

Soils in this group are used for irrigated crops. Crops grown are alfalfa, pasture, and small grain.

WILDLIFE SUITABILITY GROUP 2141

The soils in this group are fair for openland wildlife, good for woodland and rangeland wildlife, and very poor for wetland wildlife. These nonirrigated soils are moderately deep to deep and are well drained. The surface layer is loam, clay loam, silt loam, or silty clay, and in places is stony. Slope ranges from 1 to 50 percent.

The available water capacity is 8 to 12 inches to a depth of 5 feet. The water-supplying capacity is 9 to 14 inches. The average annual precipitation is 14 to 20 inches. The mean annual temperature is 38° to 45° F., and frost-free period is 80 to 110 days.

The native vegetation consists of big sagebrush, oakbrush, snowberry, bitterbrush, serviceberry, and perennial grasses, such as bluebunch wheatgrass and western wheatgrass.

WILDLIFE SUITABILITY GROUP 3141

The soils in this group are poor for openland wildlife, good for woodland and rangeland wildlife, and very poor for wetland wildlife. These nonirrigated soils are deep and are well drained to somewhat excessively drained. Usually the surface layer is gravelly or stony loam, silt loam, and fine sandy loam. Slope ranges from 8 to 80 percent.

The available water capacity ranges from 3 to 12 inches. The water-supplying capacity ranges from 11 to 20 inches. The average annual precipitation is 20 to 35 inches. The mean annual temperature is 38° to 45° F., and the frost-free period is 70 to 90 days.

The native vegetation consists of aspen, conifer, oakbrush, maple, ninebark, mountain brome, native bluegrass, and tall native wheatgrass.

WILDLIFE SUITABILITY GROUP 3212

The soils in this group are poor for openland wildlife, fair for woodland and rangeland wildlife, and good for wetland wildlife. These nonirrigated soils are deep and are poorly or very poorly drained. The surface layer is silty clay loam, silt loam, or peat. Slope ranges from 0 to 3 percent.

The water table fluctuates from ponded on the surface to a depth of 60 inches. The average annual precipitation is 8 to 14 inches. The mean annual temperature is 43° to 52° F., and the frost-free period is 100 to 130 days.

The native vegetation consists of wiregrass, sedges, saltgrass, and big rabbitbrush.

WILDLIFE SUITABILITY GROUP 3242-1

The soils in this group are poor for openland wildlife, fair for woodland and rangeland wildlife, and very poor for wetland wildlife. These irrigated soils are deep and are excessively drained to somewhat excessively drained. The surface layer is gravelly, cobbly, or sandy loam. Slope ranges from 2 to 10 percent.

The available water capacity ranges from 2 to 5 inches to a depth of 5 feet. The average annual precipitation is 8 to 14 inches. The mean annual temperature is 45° to 49° F., and the frost-free period is 110 to 130 days.

Soils in this group are used for irrigated crops. Crops grown are irrigated alfalfa, small grain, and pasture.

WILDLIFE SUITABILITY GROUP 3242

The soils in this group are poor for openland wildlife, fair for woodland and rangeland wildlife, and very poor for wetland wildlife. These nonirrigated soils are shallow to deep. The surface layer ranges from fine sandy loam to silty clay. Some soils are gravelly, cobbly, or stony. Slope ranges from 2 to 80 percent.

The available water capacity ranges from 1 to 8 inches. The water-supplying capacity is 6 to 11 inches. The average annual precipitation is 11 to 20 inches. The mean annual temperature is 40° to 50° F., and the frost-free period is 70 to 130 days.

The native vegetation is big sagebrush, bitterbrush, oakbrush, black sagebrush, yellowbrush, Indian ricegrass, and bluebunch wheatgrass.

WILDLIFE SUITABILITY GROUP 3342

The soils in this group are poor for openland and woodland wildlife, very poor for wetland wildlife, and fair for rangeland wildlife. These nonirrigated soils are deep and are well drained to somewhat excessively drained. The surface layer is fine sandy loam to clay loam and is gravelly in places. Slope ranges from 1 to 10 percent.

The available water capacity ranges from 8 to 12 inches. The water-supplying capacity ranges from 5 to 7 inches. The average annual precipitation is 8 to 12 inches. The mean annual temperature is 45° to 51° F., and the frost-free period is 100 to 130 days.

The native vegetation consists of big sagebrush, shadscale, rabbitbrush, Indian ricegrass, yellowbrush, and budsage.

WILDLIFE SUITABILITY GROUP 4343

The soils in this group are very poor for openland and wetland wildlife and fair for woodland and rangeland wildlife. These nonirrigated soils are deep to shallow over bedrock, shale, or hardpan and are somewhat excessively drained to well drained. The surface layer is usually gravelly, cobbly, or stony and ranges from clay loam to fine sandy loam. Slope ranges from 1 to 60 percent.

The available water capacity is 1½ to 6 inches. The water-supplying capacity ranges from 3 to 6 inches annually. The average annual precipitation is 8 to 15

inches. The mean annual temperature is 45° to 49° F., and the frost-free period is 100 to 130 days.

The native vegetation consists of big sagebrush, juniper, yellowbrush, Indian ricegrass, shadscale, and bitterbrush.

WILDLIFE SUITABILITY GROUP 4424

The soils in this group are very poor for openland, woodland, and rangeland wildlife and fair for wetland wildlife. These nonirrigated soils are deep and are very poorly drained to somewhat poorly drained. The surface layer is silty clay to peaty silt loam and is saline-alkali. Slope ranges from 0 to 2 percent.

The average annual precipitation is 8 to 12 inches, and the seasonal water table fluctuates from the surface to a depth of 60 inches. The mean annual temperature is 45° to 52° F., and the frost-free period is 110 to 130 days.

The native vegetation consists of saltgrass, foxtail, alkaliweed, alkali sacaton, and greasewood.

WILDLIFE SUITABILITY GROUP 4434

The soils in this group are very poor for openland, woodland, and rangeland wildlife and poor for wetland wildlife. These nonirrigated soils are deep and are poorly drained to well drained. The surface layer is silty clay to fine sandy loam and is strongly saline-alkali. Slope ranges from 0 to 5 percent.

The water-supplying capacity is usually less than 4 inches annually. The average annual precipitation is 8 to 12 inches. The mean annual temperature is 45° to 50° F., and the frost-free period is 115 to 130 days.

The native vegetation consists of greasewood, saltgrass, pickleweed, shadscale, squirreltail, and burr buttercup.

WILDLIFE SUITABILITY GROUP 4444

The land types and soil in this group are very poor for all four kinds of wildlife. These areas consist of barren rock outcrop and Rock land covered with 4 inches or less of soil material. Slope ranges from 0 to 80 percent.

The average annual precipitation is about 14 inches to 24 inches, and the water-supplying capacity ranges from 0 on the barren rocks to about 2½ inches, except in the small pockets of deeper soils that are included in areas of Rock land. The mean annual temperature is 43° to 50° F., and the frost-free period is 50 to 130 days. Vegetation is sparse and varies widely with changes in elevation and parent rocks.

This group supports very little wildlife, but the species common to the surrounding areas traverse it.

Woodland

Only about 15,000 acres in the Sanpete Valley Area is used principally for woodland. The vegetation in these areas is mainly Engelmann spruce, alpine fir, concolor fir, and Douglas-fir. In addition, approximately 13,000 acres have aspen cover and are used as range.

For the soils that are used as woodland, the management is given in the respective mapping units. These soils are in the Daybell, Flygare, Kitchell,

Mortenson, Pritchett, and Skylick series and the Mortenson variant.

Engineering

Some soil properties are of special interest to engineers because they affect the construction, maintenance, and performance of roads, airports, pipelines, building foundations, facilities for water storage, erosion-control structures, drainage systems, sanitary landfills, and sewage disposal systems. Among the properties most important to the engineer are permeability, shear strength, compressibility, compaction characteristics, soil drainage, shrink-well characteristics, grain size, plasticity, and reaction. Also important are depth to the water table, to bedrock, or to a hardpan; content of salt and alkali, and topography.

The information in this section can be used by engineers to:

1. Make studies of soil and land use that will aid in selecting and developing sites for industries, businesses, residences, and recreation.
2. Obtain estimates of the amount of runoff and the erosion characteristics of the soils for use in designing drainage structures and in planning dams and other structures that help in conserving soil and water.
3. Make reconnaissance surveys of soil and site conditions that will aid in selecting locations for highways and airports and in planning detailed soil investigations at specific sites.
4. Locate probable sources of sand and gravel for use in structures and as a base for both flexible and rigid pavements.
5. Correlate pavement performance with kinds of soil and thus develop information that will be useful in designing and maintaining pavements.
6. Determine the suitability of soils for cross-country movement of vehicles and construction equipment.
7. Supplement the information obtained from other published maps and reports and from aerial photographs.
8. Recognize limitations or properties of soils to be used for highways and earth construction where definite laboratory data are not available.

With the soil map for identification, the engineering interpretations are useful for many purposes. They do not eliminate, however, the need for sampling and testing at the site of specific engineering works. The soil map is useful for planning more detailed field investigations and for suggesting the kinds of problems that may be expected.

Much of the information in this section is in tables 4, 5, and 6. In table 4 properties of soils important to engineering are estimated. Table 5 indicates the suitability of soils for various engineering uses. Table 6 gives test data for several soil types that are extensive in the survey area.

Engineering classification systems

Two systems of classifying soils in general use among engineers are used in this report. In table 4 the estimated classifications of the soils are presented according to both systems.

The American Association of State Highway and Transportation Officials (AASHTO) system (1) of classifying soils is an engineering-property classification based on field performance of highways. It is the most widely known system used in highway practice. Under this system, grouping soils of about the same general load-carrying capacity and service characteristics resulted in seven basic groups designated as A-1 to A-7. The best soils for road subgrades are classified as A-1; the poorest soils are classified as A-7.

The Unified Soil Classification System (2) is based on the soil classification system developed by Dr. Arthur Casagrande, of Harvard University, for the Corps of Engineers during World War II. The original classification has been revised and expanded to apply to embankments and foundations as well as to roads and airfields. It is used by the Department of Defense and others.

In the Unified system, soils are identified according to their grain size and plasticity and are grouped according to their performance as engineering construction material. Soil materials are classified as coarse grained—gravels (G) and sands (S); fine grained—silts (M) and clays (C); and highly organic (O). In this system clean sands are identified by the symbols SW and SP; sands with fines of silt and clay, by SM and SC; silts and clays that have low liquid limit, by ML and CL; and silts and clays that have high liquid limit, by MH and CH.

Estimated engineering properties and soil interpretations

Some of the soil properties significant in engineering are estimated in table 4. These estimates are based on comparisons with the known properties of the soils tested in table 6, on field studies, and on comparisons with similar soils in other areas. Estimates are valid only to the depth stated in the depth to bedrock column. The estimated interpretations in table 5 are based on the engineering properties of soils shown in tables 4 and 6. They summarize the limitation or suitability of the soils for a number of specific purposes.

Soil limitations are rated as slight, moderate, and severe. *Slight* means that limitations are minor and easily overcome; *moderate* means that some properties are unfavorable but can be overcome or modified by special planning and design; and *severe* means soil properties so unfavorable that major soil reclamation and special designs are needed to correct or overcome them.

Following are explanations of some of the columns in tables 4 and 5.

Hydrologic groupings relate to drainage of the soil. Group A soils have a high infiltration rate and low runoff potential even when thoroughly wetted. This group consists mainly of well-drained to excessively drained deep sands or gravelly soils. Group B soils have a moderate infiltration rate when thoroughly

wetted, and consist mainly of moderately deep to deep, moderately well drained and well drained soils that are moderately fine to moderately coarse and have moderately slow permeability to moderately rapid permeability. Group C soils have a slow infiltration rate when thoroughly wetted and consist mainly of soils that have a layer that impedes downward movement of water, soils that are moderately fine to fine, soils with slow infiltration due to salts or alkali, or soils with moderately deep water tables. These soils are somewhat poorly drained or well drained to moderately well drained and are slowly permeable and very slowly permeable between depths of 20 and 40 inches. Group D soils have a very slow infiltration rate when thoroughly wetted and consist mainly of clay soils with high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, soils with a very slow infiltration rate due to salts or alkali, and shallow soils over nearly impervious materials.

USDA texture is determined by the relative proportions of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Sand," "Silt," "Clay," and some of the other terms used in the USDA textural classifications are defined in the Glossary at the back of this survey.

Permeability, as used in table 4, relates only to the rate of movement of water downward through undisturbed and uncompacted soil when it is thoroughly wetted. It does not include lateral seepage. The estimates are based on structure and porosity of the soil. Plowpans, surface crusts, and other properties resulting from use of the soils are not considered.

Available water capacity is the capacity of soils to store water for use by most plants. It is commonly defined as the difference between the amount of water in the soil at field capacity and the amount at the wilting point of most crop plants.

Reaction is the degree of acidity or alkalinity of a soil, expressed as a pH value. The pH value and relative terms used to describe soil reaction are explained in the Glossary.

Salinity of the soil is based on the electrical conductivity of the saturated soil extract, as expressed in millimhos per centimeter at 25° C. Salinity affects the suitability of a soil for crop production, its stability when used as a construction material, and its corrosivity in relation to other materials.

Shrink-swell potential is an indication of the volume change to be expected of the soil material with changes in moisture content. Shrinking and swelling of soils cause much damage to building foundations, roads, and structures. A high shrink-swell potential indicates hazards to the maintenance of structures constructed in, on, or with such materials.

Table 5 contains selected information useful to engineers and others who plan to use soil material in construction of highways, farm facilities, buildings, sanitary landfills, sewage disposal systems, and for urban and recreational planning. Detrimental or undesirable features are emphasized, but very important desirable features also may be listed. While, strictly, the information applies only to soil depths indicated in table

4, it is reasonably reliable to a depth of about 6 feet for most soils and to an even greater depth for some.

Septic tank absorption fields are affected mainly by permeability, depth to water table, susceptibility to flooding, slope, and stoniness. The degree of limitation and principal reasons for assigning moderate or severe limitations are given.

Shallow excavations are those that require excavating or trenching to a depth of 5 or 6 feet or less. Such uses include pipelines, sewers, cables, basements, cemeteries, landfills, etc. Important features affecting ratings are drainage, depth to water table, flooding, soil texture and depth, slope, and stoniness.

Limitations for dwellings without basements are for undisturbed soil foundations for single-family dwellings of three stories or less. Emphasis for rating is on bearing capacity, settlement potential, slope, flooding, drainage class or depth to water table, depth to bedrock, stoniness and rockiness, and potential frost action.

Trench type sanitary landfill is a dug trench in which refuse is buried daily with at least a 6-inch layer of soil and a final cover of at least 2 feet of soil. Important limitations are permeability, slope, soil texture and depth, depth to bedrock, drainage, and depth to water table.

Local roads and streets are those that have all weather surfacing, commonly asphalt or concrete. Ratings are based on shrink-swell potential, susceptibility to frost action, drainage, slope, depth, and stoniness of the soil.

Road fill is material used to build embankments. The ratings indicate performance of soil material moved from borrow areas for these purposes.

Sand and gravel ratings are based on the probability that delineated areas of the soil contain deposits of sand and gravel. The ratings do not indicate quality or size of the deposits.

Topsoil designates a fertile soil or soil material, ordinarily rich in organic matter, used as a topdressing for lawns, gardens, and roadbanks. The ratings indicate suitability for such use.

Pond reservoir areas are affected mainly by loss of water by seepage, and the important soil features are those that influence seepage.

Embankments serve as dams, dikes, and levees. The soil features that affect them are high water table, shrink-swell potential, compactibility, susceptibility to piping, and depth over bedrock.

Features affecting drainage of cropland or pasture are permeability, texture, slope, soil depth, and availability of drainage outlets.

Irrigation is affected by soil texture, available water capacity, depth, slope, depth to water table, erodibility, intake rate, stoniness, salinity or alkalinity, and fertility.

The estimates given in tables 4 and 5 provide much information useful to engineers. They are not a suitable substitute, however, for the detailed tests needed at a specific site selected for construction.

In addition to this section, the sections "Descriptions of the Soils," "Classification of the Soils," and other parts of the soil survey are useful to engineers. Other terms used in soil science may not be familiar

TABLE 4.—*Estimated soil properties*

[An asterisk in the first column indicates at least one mapping unit in this series is made up of two or more kinds of soil that may have appear in the first column. The symbol >

Soil series and map symbols	Hydro- logic group- ing	Depth to sea- sonally high water table ¹	Depth to bedrock	Depth from surface	Dominant USDA texture	Classification		Per- cent cobble (>3.0 inches)
						Unified	AASHTO	
		<i>Inches</i>	<i>Feet</i>	<i>Inches</i>				
*Abcal:								
Aa.....	D	0-40	>5	0-60	Silty clay and clay.	CH or MH	A-7	0
Ab, Ac..... For Cache part of Ac, see Cache series.	D	0-40	>5	0-60	Silty clay and clay.	CH or MH	A-7	0
Adel: ADG.....	A	-----	3.5->5	0-60	Silt loam.....	ML or CL- ML	A-4	0-5
Amtoft: AEE, AFG2.....	D	-----	1-1.7	0-20 20	Very flaggy loam. Fractured lime- stone bed- rock.	GM, GC, SM, or SC	A-2	25-35
Anco: Ag.....	C	30-60	>5	0-60	Silty clay loam..	CL	A-6	0
*Ant Flat: AHD, AHE2, AkC, ALD..... For Borvant part of ALD, see Borvant series.	C	-----	3.5->5	0-12 12-40 40-60	Loam and silt loam. Silty clay..... Clay loam and loam.	CL or CL- ML CH CL	A-4 A-7 A-6	0 0 0
*Arapien: AmB, AmC2, AmD2, AnB, AoB, ARD. For Calita part of ARD, see Calita series.	C	-----	3.5->5	0-48 48-60	Loam..... Gravelly sandy loam.	CL or CL- ML SM or GM	A-4 or A-6 A-2	0 0
ApC2.....	C	-----	3.5->5	0-23 23-60	Clay loam..... Gravelly clay loam.	CL GC	A-6 A-2	0 30-40
Atepic: ASE2, ATF, AV..... No valid estimates for Badland part of AV.	D	-----	1-1.7	0-20 20	Shaly silty clay loam and shaly clay loam. Shale bedrock.	ML	A-4	10-15
Atepic variant: AUF.....	D	-----	1-1.7	0-20 20	Gravelly clay.. Shale bedrock.	MH, ML, or GM	A-7 or A-2	5-10
Badland: BA. No valid estimates can be made.								
*Bagard: BCE, BDE..... For Sanpitch part of BDE, see San- pitch series.	C	-----	3.5->5	0-14 14-60	Cobbly clay loam. Very cobbly clay to very cobbly loam.	GC GC or GM	A-6 A-2	15-20 30-35
Beek: Be.....	C	20-60	>5	0-60	Silty clay loam..	CL	A-6	0
*Bezzant: BFD, BGE, BH..... For Gappmayer part of BH, see Gapp- mayer series.	B	-----	>5	0-60	Very cobbly gravelly loam or very stony sandy loam.	GM, GC, SM, or SC	A-4 or A-2	30-60

See footnotes at end of table.

significant in engineering

different properties and limitations. For this reason it is necessary to follow carefully the instructions for referring to other series that means more than; < means less than]

Percentage less than 3 inches passing sieve—				Liquid limit	Plastic- ity index	Permea- bility	Avail- able water capacity	Reaction	Salinity	Shrink- swell potential
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)							
				<i>Percent</i>		<i>Inches per hour</i>	<i>Inches per inch of soil</i>	<i>pH</i>		
-----	100	90-100	85-95	50-60	20-30	0.06-0.2	0.14-0.20	7.9-9.5	Slight to moderate	High.
-----	100	90-100	85-95	50-60	20-30	0.06-0.2	0.02-0.04	7.9-9.5	Strong-----	High.
80-100	70-90	65-85	50-70	25-35	5-10	0.6-2.0	0.14-0.20	5.6-7.3	None-----	Low to moderate.
50-70	45-60	35-45	25-35	20-30	5-10	2.0-6.0	0.07-0.11	7.9-9.0	None-----	Low.
90-100	90-100	85-100	85-95	30-40	10-15	0.2-0.6	0.14-0.20	7.9-9.5	Slight to moderate	Moderate.
-----	100	85-95	60-75	20-30	5-10	0.6-2.0	0.13-0.19	6.1-7.3	None-----	Low.
-----	100	95-100	85-95	50-60	25-35	0.06-0.2	0.14-0.20	6.1-8.4	None-----	High.
100	90-100	85-95	60-75	30-40	10-20	0.2-0.6	0.14-0.20	6-6-8.4	None-----	Moderate.
90-100	90-100	85-95	55-65	25-35	5-15	0.6-2.0	0.13-0.19	7.9-9.0	None-----	Low.
50-80	45-75	30-75	15-35	20-30	⁴ NP-5	2.0-6.0	⁵ 0.08-0.12	⁶ -----	Strong-----	Low.
90-100	90-100	85-95	70-80	30-40	10-20	0.2-0.6	0.14-0.20	7.9-9.5	None to moderate	Moderate.
35-45	25-40	20-35	15-30	20-30	10-15	0.6-2.0	0.06-0.10	7.9-9.5	None to moderate	Low.
65-90	60-85	55-85	50-80	30-40	5-10	0.06-0.2	0.13-0.17	7.9-9.0	None-----	Moderate.
40-80	35-70	30-65	25-65	40-60	15-25	0.06-0.2	0.12-0.18	7.9-9.0	None-----	Moderate.
60-75	50-65	45-60	35-50	30-40	10-20	0.6-2.0	0.08-0.12	6.1-7.3	None-----	Moderate.
30-55	25-50	20-45	15-35	35-45	10-20	0.2-0.6	0.06-0.10	6.1-8.4	None-----	Moderate.
-----	100	95-100	85-95	30-40	10-20	0.2-0.6	0.14-0.20	7.9-9.5	None-----	Moderate.
40-75	35-65	25-60	15-45	25-35	5-10	0.6-2.0	0.09-0.12	6.6-9.0	None-----	Low.

TABLE 4.—Estimated soil properties

Soil series and map symbols	Hydro- logic group- ing	Depth to sea- sonally high water table ¹	Depth to bedrock	Depth from surface	Dominant USDA texture	Classification		Per- cent cobble (>3.0 inches)
						Unified	AASHTO	
		<i>Inches</i>	<i>Feet</i>	<i>Inches</i>				
Billings: Bm.....	C	-----	>5	0-60	Silty clay loam or clay loam.	CL	A-6	0
Birdow: BnB, BnC..... No valid estimates for BoB; onsite in- vestigation needed.	B	-----	>5	0-60	Very fine sandy loam.	CL, CL- ML, SM, or SC	A-4	0
*Borvant: BRD2, BSE2, BTC, BUD2..... For Lodar part of BUD2, see Lodar series. For Doyce part of BTC, see Doyce series. For Bagard part of BSE2, see Bagard series.	D	-----	>5	0-20 20	Very gravelly loam or gravelly loam. Indurated lime hardpan.	GM, GC, SM, or SC	A-4 or A-2	15-30
Bradshaw: BVG.....	B	-----	3.5- >5	0-60	Very cobbly fine sandy loam.	SM or GM	A-2, A-4	30-75
Cache..... Mapped only with Abcal soil.	D	20-40	>5	0-60	Silty clay.....	CH or CL	A-7	0
Calita: CaB, CaC.....	B	-----	>5	0-60	Loam.....	ML or CL- ML	A-4	0
Canburn: Cb.....	B	0-50	>5	0-60	Silty clay loam..	CL	A-6	0
Centerfield: CcB, CcC2.....	B	-----	1-1.7	0-20 20-60	Silty clay loam.. Very gravelly sandy loam.	CL or CL- ML GM or GP- GM	A-6 or A-4 A-1	0 20-30
Chealle: CDG.....	C	-----	1-1.7	0-20 20	Very flaggy silt loam. Hard sandstone bedrock.	GM	A-2 or A-1	45-60
*Chipman: Ch, Cm..... For Poganeab part of Cm, see Poganeab variant.	D	10-30	>5	0-60	Silty clay loam or clay loam.	CL	A-6	0
Clegg: CNC.....	B	-----	>5	0-34 34-60	Loam, silt loam, or clay loam. Clay loam or gravelly loam.	CL CL or CG	A-6 A-6	0 0
Collard: CoC, CRD.....	B	-----	>5	0-20 20-60	Gravelly sandy loam, very gravelly sandy clay loam. Very cobbly loamy sand.	GM or SM GW, GP, or GM	A-1, A-2 A-1	15-25 15-25
Crestline: CsC.....	B	-----	>5	0-19 19-60	Loam and sandy clay loam. Sandy loam and loamy sand.	SM, SC, or ML SM	A-4 A-2 or A-4	0 0

See footnotes at end of table.

significant in engineering—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plastic- ity index	Permea- bility	Avail- able water capacity	Reaction	Salinity	Shrink- swell potential
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)							
				Percent		Inches per hour	Inches per inch of soil	pH		
-----	100	95-100	85-95	25-35	10-15	0.06-0.2	0.14-0.20	8.5-9.0	None-----	Moderate.
75-100	70-100	60-95	35-65	25-35	5-10	0.6-2.0	0.13-0.18	7.4-9.0	None-----	Low.
40-70	35-65	30-60	20-40	25-35	5-10	2.0-6.0	0.10-0.14	7.4-9.5	None-----	Low.
45-90	40-85	25-70	15-40	20-25	0-5	2.0-6.0	0.05-0.09	6.1-7.8	None-----	Low..
-----	100	95-100	85-95	45-55	20-30	0.06-0.2	0.02-0.05	8.5-9.0	Very strong-----	High.
90-100	90-100	85-95	55-70	25-35	5-10	0.6-2.0	0.13-0.19	7.4-9.0	None-----	Low.
-----	100	90-100	85-95	30-40	10-15	0.2-0.6	0.14-0.20	7.9-9.0	None-----	Moderate.
-----	100	90-100	85-95	25-35	5-15	0.2-0.6	0.14-0.20	7.9-9.0	Slight-----	Moderate.
25-60	20-50	5-35	5-15	15-20	NP	6.0-20	0.03-0.07	7.9-9.0	Slight-----	Low.
35-65	25-55	25-45	20-35	20-30	0-5	6.0-20	0.04-0.08	6.6-8.4	None-----	Low.
-----	100	95-100	85-95	30-40	10-15	0.2-0.6	0.14-0.20	7.9-9.0	None-----	Moderate.
-----	100	90-100	70-80	30-40	10-15	0.2-0.6	0.14-0.20	6.6-8.4	None-----	Moderate.
65-100	60-100	55-100	70-80	30-40	10-15	0.2-0.6	0.14-0.20	6.6-8.4	None-----	Moderate.
50-75	45-70	40-65	15-30	20-25	0-5	6.0-20	0.07-0.10	6.1-7.8	None-----	Low.
50-75	45-70	40-65	0-15	15-20	NP	20+	0.02-0.05	6.1-7.8	None-----	Low.
95-100	90-100	75-95	40-60	25-35	5-10	0.2-0.6	0.14-0.20	8.5-9.0	None-----	Low.
75-100	70-100	50-75	15-40	20-25	0-5	2.0-6.0	0.06-0.11	8.5-9.0	None-----	Low.

TABLE 4.—Estimated soil properties

Soil series and map symbols	Hydro- logic group- ing	Depth to sea- sonally high water table ¹	Depth to bedrock	Depth from surface	Dominant USDA texture	Classification		Per- cent cobble (>3.0 inches)
						Unified	AASHTO	
		<i>Inches</i>	<i>Feet</i>	<i>Inches</i>				
Cryoborolls: CU. No valid estimates can be made.								
*Daybell: DAG, DBG..... For Flygare part of DBG, see Flygare series.	A	-----	>5	0-22 22-60	Gravelly silt loam. Very gravelly very fine sandy loam.	GM GM	A-4 or A-2 A-1	0 40-60
*Deer Creek: DCD, DED, DEE, DFF..... For Mower part of DFF, see Mower series.	C	-----	3.5->5	0-10 10-34 34-60	Stony silt loam and silt loam. Cobbly clay..... Cobbly clay loam.	CL or CL- ML CH or CL CL	A-4 or A-6 A-7 A-6	10-15 30-50 30-50
Denmark: DgC.....	D	-----	3.5->5	0-20 20	Gravelly loam.. Indurated hardpan.	SM, SC, GM, ML, or CL- ML	A-4	10-15
Donnardo: DhD, DKD, DLD.....	B	-----	>5	0-60	Very cobbly loam.	SM, GM, SC, or GC	A-4	40-55
Doyce: DoB, DoC, DrB.....	C	7 -----	3.5->5	0-20 20-60	Loam and sandy clay loam. Loam, sandy clay loam, cobbly or stony sandy clay loam.	ML or SM SM, SC, CL, or CL- ML	A-4 A-4 or A-2	0 0-30
Dyreg: Ds.....	D	30-60	>5	0-60	Silty clay or heavy silty clay loam.	CL	A-6 or A-7	0
Dy.....	D	30-60	>5	0-60	Silty clay or heavy silty clay loam.	CL	A-6 or A-7	0
Ephraim: Ep.....	C	30-60	>5	0-62	Silty clay loam, silty clay, and clay loam.	CL	A-6	0
Fluvaquents: FN. No valid estimates can be made.		0-20						
Flygare..... Mapped only with Daybell soil.	B	-----	>5	0-24 24-60	Gravelly silt loam. Very cobbly or very gravelly very fine sandy loam and very gravelly light clay loam.	ML, GM, GC, or CL- ML SM, SC, GM, or GC	A-4 A-2	0 40-55

See footnotes at end of table.

significant in engineering—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plastic- ity index	Permea- bility	Avail- able water capacity	Reaction	Salinity	Shrink- swell potential
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)							
				<i>Percent</i>		<i>Inches per hour</i>	<i>Inches per inch of soil</i>	<i>pH</i>		
45-65	40-60	35-55	30-50	20-30	0-5	6.0-20	0.09-0.13	5.6-7.3	None.....	Low.
30-55	25-50	20-40	15-25	20-25	NP	6.0-20	0.03-0.07	5.6-7.3	None.....	Low.
85-100	80-95	75-85	55-70	25-35	5-15	0.6-2.0	0.11-0.15	6.1-7.3	None.....	Low.
90-100	80-90	70-85	60-80	45-55	20-30	0.06-0.2	0.10-0.14	6.6-7.8	None.....	High.
75-90	70-80	65-75	50-60	30-40	10-20	0.2-0.6	0.10-0.14	7.4-9.0	None.....	Moderate.
60-95	55-90	50-75	35-70	25-35	5-10	2.0-6.0	0.10-0.14	7.9-9.0	None.....	Low.
						<0.06				
55-90	50-85	40-75	35-45	20-30	5-10	6.0-20	0.07-0.11	7.4-9.0	None.....	Low.
100	90-100	80-95	40-60	30-40	5-15	0.2-0.6	0.13-0.19	6.6-8.4	None.....	Moderate.
70-90	70-85	55-75	30-65	15-25	5-10	0.2-0.6	0.11-0.16	7.9-9.0	None.....	Low.
-----	100	95-100	90-100	35-50	15-30	0.06-0.2	0.14-0.20	7.9-9.0	Slight.....	High to moder- ate.
-----	100	95-100	90-100	35-50	15-30	0.06-0.02	0.02-0.06	7.9-9.0	Strong.....	High to moder- ate.
-----	100	95-100	85-95	30-40	10-20	0.2-0.6	0.07-0.10	7.9-9.5	Slight to moderate	Moder- ate.
60-95	55-90	50-85	40-80	25-35	5-10	0.6-2.0	0.09-0.13	5.6-7.3	None.....	Low.
30-55	25-50	20-45	15-35	20-30	5-10	6.0-20	0.04-0.08	5.6-7.3	None.....	Low.

TABLE 4.—Estimated soil properties

Soil series and map symbols	Hydro- logic group- ing	Depth to sea- sonally high water table ¹	Depth to bedrock	Depth from surface	Dominant USDA texture	Classification		Per- cent cobble (>3.0 inches)
						Unified	AASHTO	
		<i>Inches</i>	<i>Feet</i>	<i>Inches</i>				
*Fontreen: FOD, FRE2, FRG2, FSD2..... For Borvant part of FSD2, see Bor- vant series.	B	-----	>5	0-60	Very cobbly loam and very gravelly loam.	GC-GM or GC	A-1 or A-2	15-30
*Freedom: FTD..... For Amtoft part of FTD, see Amtoft series.	C	-----		0-60	Silty clay loam and silt loam.	ML or CL	A-6 or A-4	0
Gappmayer..... Mapped only with Bezzant and Rock land.	B	-----	>5	0-72	Very cobbly loam and very cobbly sandy clay loam.	GC	A-2 or A-6	35-65
Genola: GeB, GeC2, GeD2.....	B	-----	>5	0-61	Stratified loam, silt loam, silty clay loam, fine sandy loam.	CL-ML or CL	A-4 or A-6	0
GkB.....	B	-----	>5	0-61	Stratified loam, silt loam, silty clay loam, fine sandy loam.	CL- ML or CL	A-4 or A-6	0
Gothic: GOF2.....	C	-----	>5	0-12 12-60	Clay loam..... Cobbly clay.....	CL CL or CH	A-6 A-7	0 15-40
Green River: Gr.....	B	30-60	>5	0-60	Stratified fine sandy loam, silt loam, clay loam, and loamy sand.	SM-SC, SM, SC, CL, CL- ML	A-4	0
Gullied land: Gu. No valid estimates can be made.								
Harding: Ha.....	D	-----	>5	0-33 33-60	Silty clay..... Silty clay loam..	CL CL	A-7 A-6	0 0
Harkers: HED, HKE.....	C	-----	>5	0-12 12-60	Silt loam and cobbly silt loam. Cobbly clay or cobbly heavy clay loam.	CL-ML or ML CH or CL	A-4 A-7	10-25 20-30
Keigley: KeB.....	C	-----	>5	0-60	Silty clay loam..	CL	A-4 or A-6	0
*Kitchell: KEG, KM..... For Mower part of KM, see Mower series.	B	-----	>5	0-60	Very cobbly loam, very stony loam, or very gravelly loam.	GC or GC- GM	A-4 or A-2	25-50

See footnotes at end of table.

significant in engineering—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plastic- ity index	Permea- bility	Avail- able water capacity	Reaction	Salinity	Shrink- swell potential
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)							
				<i>Percent</i>		<i>Inches per hour</i>	<i>Inches per inch of soil</i>	<i>pH</i>		
35-50	30-45	25-40	20-35	20-30	5-10	2.0-6.0	0.07-0.10	7.4-9.5	None-----	Low.
-----	100	95-100	85-95	30-40	5-15	0.2-0.6	0.14-0.20	7.9-9.5	None-----	Moderate.
30-70	25-60	20-55	15-45	25-40	10-15	6.0-20	0.06-0.10	5.6-8.4	None-----	Low.
-----	100	85-95	60-80	25-35	5-15	0.6-2.0	0.13-0.19	7.9-9.5	None to slight-----	Moderate.
-----	100	85-95	60-80	25-35	5-15	0.6-2.0	0.03-0.04	8.5-9.5	Strong-----	Moderate.
-----	100	85-100	65-80	30-40	10-15	0.2-0.6	0.14-0.20	6.1-7.3	None-----	Moderate.
80-100	75-100	70-100	65-95	45-60	25-40	0.06-0.2	0.11-0.15	6.6-8.4	None-----	High.
-----	100	60-80	35-60	20-30	5-10	0.6-2.0	0.10-0.13	7.9-9.0	None-----	Low.
-----	100	95-100	85-95	40-50	20-30	0.06-0.2	0.04-0.06	8.5-10.0	Moderate to strong-----	Moderate
-----	100	95-100	85-95	30-40	10-20	0.06-0.2	0.02-0.04	8.5-10.0	Strong to very strong.	to high. Moderate.
80-95	75-90	70-85	65-80	25-35	5-10	0.2-0.6	0.11-0.15	6.1-7.3	None-----	Low.
75-85	70-80	65-80	50-75	45-60	20-40	0.06-0.2	0.11-0.15	6.1-7.3	None-----	High.
-----	100	95-100	85-95	30-40	10-15	0.2-0.6	0.14-0.20	7.4-9.5	None-----	Moderate.
50-75	40-70	35-65	25-50	20-30	5-10	2.0-6.0	0.07-0.10	6.6-9.0	None-----	Low.

TABLE 4.—*Estimated soil properties*

Soil series and map symbols	Hydro- logic group- ing	Depth to sea- sonally high water table ¹	Depth to bedrock	Depth from surface	Dominant USDA texture	Classification		Per- cent cobble (>3.0 inches)
						Unified	AASHTO	
		<i>Inches</i>	<i>Feet</i>	<i>Inches</i>				
Kjar: Kp.....	D	0-10	>5	0-8	Peaty silt loam..	Pt	A-8	0
				0-60	Silt loam.....	ML or CL- ML	A-4	0
Linoyer: LdB, LdC2.....	B		>5	0-60	Very fine sandy loam and silt loam.	ML	A-4	0
*Lisade: LdB, LdC2, LFC2..... For Sanpete part of LFC2, see Sanpete series.	B		>5	0-60	Loam, sandy loam, and gravelly sandy loam.	SM	A-2 or A-1	5
*Lizzant: LGE, LHD, LKG, LLE, LMF, LNE, LOF. For Clegg part of LLE, see Clegg series. For Sedwell part of LNE, see Sed- well series. For Kitchell part of LOF, see Kitch- ell series. For Mower part of LMF, see Mower series.	B		>5	0-60	Very cobbly loam.	GM	A-1 or A-2	20-65
*Lodar: LRE, LSG, LTE, LTG..... For Fontreen part of LSG, see Fon- treen series.	D		1-1.7	0-20 20	Very gravelly loam. Limestone bedrock.	GM	A-4 or A-2	15-50
Lundy: LUE.....	D		1-1.7	0-20	Very flaggy clay loam.	GM-GC or GM	A-2	25-45
*Manassa: MA..... For Mellor part of MA, see Mellor series.	C		>5	0-60	Silty clay loam, silt loam, and loam.	CL or CL- ML	A-6	0
Manila: MbC.....	C		>5	0-17 17-60	Loam and silt loam. Silty clay, clay, and silty clay loam.	CL CH or CL	A-6 or A-4 A-7	0 0-5
Mayfield: McB, McB2.....	B		>5	0-65	Shaly loam or loam to shaly silty clay loam.	GM or GC- GM	A-4	5-10
Mellor: Md.....	D		>5	0-60	Silty clay loam and silt loam.	CL or CL- ML	A-6 or A-4	0
Me.....	D		>5	0-60	Silty clay loam and silt loam.	CL or CL- ML	A-6 or A-4	0
*Moroni: MfC, MGD..... For Atepic part of MGD, see Atepic series.	D		>5	0-60	Silty clay.....	MH	A-7	0
*Mortenson: MHG, MKG..... For Skylick part of MKG, see Skylick series.	C		>5	0-12 12-60	Silt loam..... Very stony clay or very stony silty clay loam.	CL-ML or CL CL or GC	A-4 A-6, A-7, or A-2	0-15 25-60

See footnotes at end of table.

significant in engineering—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plastic- ity index	Permea- bility	Avail- able water capacity	Reaction	Salinity	Shrink- swell potential
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)							
				Percent		Inches per hour	Inches per inch of soil	pH		
	100	90-100	70-90	15-25	0-5	0.6-2.0	0.08-0.12	7.9-9.0	Moderate to strong	Low.
100	90-100	75-100	65-85	20-30	0-5	0.6-2.0	0.13-0.18	7.9-9.0	None	Low.
65-90	55-85	35-60	20-35	20-30	0-5	2.0-6.0	0.08-0.12	7.9-9.0	None	Low.
45-65	30-65	25-50	20-35	20-30	0-5	2.0-6.0	0.06-0.10	7.4-9.0	None	Low.
40-60	35-55	30-50	20-40	20-30	0-5	2.0-6.0	0.07-0.11	7.4-9.0	None	Low.
30-50	25-45	20-40	20-35	25-35	5-10	2.0-6.0	0.04-0.08	6.6-8.4	None	Low.
	100	95-100	85-95	25-40	5-15	0.06-0.2	0.03-0.05	7.9-9.5	Strong	Moderate.
	100	85-95	60-75	25-35	5-15	0.6-2.0	0.13-0.19	6.1-7.3	None	Moderate.
85-100	80-100	75-100	75-95	45-60	20-35	0.06-0.2	0.14-0.20	6.1-7.3		High.
60-75	55-70	50-65	35-50	25-35	5-10	2.0-6.0	0.09-0.13	7.9-9.5	Slight to moderate	Low.
	100	90-100	75-95	25-40	5-15	0.06-0.2	0.01-0.03	8.5-9.5	Moderate to very strong.	Moderate.
	100	90-100	75-95	25-40	5-15	0.06-0.2	0.08-0.18	7.9-9.5	Slight to strong	Moderate.
	100	95-100	85-95	55-65	15-25	0.06-0.2	0.14-0.20	7.4-9.0	None	High.
95-100	90-100	80-100	65-90	20-30	5-10	0.6-2.0	0.11-0.18	5.6-7.3	None	Low.
40-80	35-75	30-70	30-65	30-45	15-20	0.06-0.2	0.08-0.12	5.6-7.3	None	Moderate.

TABLE 4.—Estimated soil properties

Soil series and map symbols	Hydro- logic group- ing	Depth to sea- sonally high water table ¹	Depth to bedrock	Depth from surface	Dominant USDA texture	Classification		Per- cent cobble (>3.0 inches)
						Unified	AASHTO	
		<i>Inches</i>	<i>Feet</i>	<i>Inches</i>				
Mortenson variant: MLD.....	C		3.5->5	0-44 44	Clay and cobbly clay. Shale bedrock.	CL	A-6 or A-7	0-20
*Mountainville: MmC, MnC, MoC..... For Doyce part of MoC, see Doyce series.	B	-----	>5	0-60	Very stony sandy clay loam and stony sandy loam.	SM	A-2	30-60
Mountainville variant: MrD.....	C	-----	3.5->5	0-23 23	Very cobbly clay loam to cobbly loam. Indurated hardpan.	GC or SC	A-2 or A-6	25-45
*Mower: MSD, MTD, MUF2, MVE..... For Lundy part of MVE, see Lundy series.	C	-----	2-3.5	0-35	Clay loam and silty clay loam.	CL-ML or CL	A-6 or A-4	0
Obrast: ObC, OCD, ODD ^a	D	-----	3.5->5	0-60	Silty clay.....	CH	A-7	0
*Pavant: PaC, PDC..... For Doyce part of PDC, see Doyce series.	D	-----	3->5	0-17 17	Clay loam..... Hardpan.	ML	A-4 or A-6	0
Peteetneet: Pe.....	D	0-60	>5	0-60	Peat and muck..	Pt	-----	-----
Poganeab: Pg.....	D	0-40	>5	0-60	Silt loam and silty clay loam.	CL	A-6	0
Ph.....	D	0-40	>5	0-60	Silt loam and silty clay loam.	CL	A-6	0
Poganeab variant: Pk.....	D	20-36	>5	0-60	Silt loam or silty clay loam.	ML	A-4	0
Pritchett: PRF, PTE.....	C	-----	>5	0-12 12-24 24-60	Silt loam..... Stony silt loam and very stony very fine sandy loam. Cobbly clay....	CL-ML or ML GM-GC, GM, SM- SC, or SM CL or CH	A-4 A-4 A-7	5-10 30-55 45-60
*Quaker: QkB, QkC.....	C	-----	>5	0-60	Silty clay loam..	CL	A-6	0
Qm..... For Mellor part of Qm, see Mellor series.	C	-----	>5	0-60	Silty clay loam..	CL	A-6	0

See footnotes at end of table.

significant in engineering—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plastic- ity index	Permea- bility	Avail- able water capacity	Reaction	Salinity	Shrink- swell potential
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)							
85-100	80-100	70-100	60-90	Percent 35-50	15-25	Inches per hour 0.06-0.2	Inches per inch of soil 0.14-0.16	pH 6.6-8.4	None.....	High.
65-90	50-85	40-75	20-35	20-30	0-5	0.6-2.0	0.07-0.11	6.6-9.0	None.....	Low.
45-80	40-75	35-65	25-40	30-40	10-20	0.06-0.2	0.08-0.10	7.4-9.0	None.....	High.
85-95	80-95	70-90	70-85	25-35	5-15	0.6-2.0	0.14-0.18	7.4-9.0	None.....	Moderate.
90-100	90-100	90-100	85-95	60-70	35-45	<0.06	0.14-0.20	6.6-8.4	None.....	High.
80-100	70-95	70-90	50-75	30-40	5-15	0.06-0.2	0.14-0.20	7.4-8.4	None.....	Moderate.
-----	-----	-----	-----	-----	-----	0.6-2.0	0.19-0.23	7.4-8.4	Slight to moderate.	None.
-----	100	95-100	85-95	30-40	10-20	0.2-0.6	0.14-0.20	7.9-9.0	Slight to moderate.	Moderate.
-----	100	95-100	85-95	30-40	10-20	0.2-0.6	0.03-0.05	7.9-9.0	Strong.....	Moderate.
-----	100	90-100	70-90	25-35	0-10	0.2-0.6	0.11-0.15	8.5-9.0	Slight to moderate.	Low.
80-95	75-90	70-85	50-75	20-35	5-10	0.6-2.0	0.11-0.15	5.6-7.3	None.....	Low.
55-85	50-80	45-75	35-50	25-35	5-10	0.6-2.0	0.07-0.10	5.6-7.3	None.....	Low.
80-95	70-90	65-85	50-75	45-55	20-35	0.2-0.6	0.07-0.10	5.6-7.3	None.....	Moderate.
-----	100	95-100	85-95	25-35	10-15	0.2-0.6	0.09-0.13	7.9-9.5	None to slight.....	Moderate.
-----	100	95-100	85-95	25-35	10-15	0.2-0.6	0.03-0.05	7.9-9.5	Strong.....	Moderate.

TABLE 4.—Estimated soil properties

Soil series and map symbols	Hydro- logic group- ing	Depth to sea- sonally high water table ¹	Depth to bedrock	Depth from surface	Dominant USDA texture	Classification		Per- cent cobble (>3.0 inches)
						Unified	AASHTO	
		<i>Inches</i>	<i>Feet</i>	<i>Inches</i>				
Rapho: RaC, RaD.....	B		>5	0-60	Gravelly very fine sandy loam.	GM or SM	A-2	5-10
Ravola: RiB, RiC, RiC2.....	B		>5	0-60	Loam.....	CL-ML or ML	A-4	0
Rock land: RO. No valid estimates can be made.								
Sanpete: SaC, SbD2, SCE2.....	B		>5	0-60	Very gravelly fine sandy loam.	GC-GM or GC	A-2 or A-1	15-50
*Sanpitch: SDE, SEE..... For Obrast part of SEE, see Obrast series.	C		>5	0-60	Gravelly loam....	GC-GM, GM, SM, or SC- SM	A-4	5-10
Sanpitch variant: SFD.....	C		>5	0-60	Loam and gravelly loam.	CL-ML or ML	A-4	0
Sedwell..... Mapped only with Lizzant soil.	C		3.5->5	0-47 47	Silt loam, silty clay loam, and cobbly silty clay loam. Shale bedrock.	CL	A-6	10-25
Shaly colluvial land: SH. No valid estimates can be made.								
Shumway: Sm, Sn.....	D	10-60	>5	0-60	Silty clay.....	CL	A-7	0
Sigurd: SoD2, SpC.....	B		>5	0-60	Very gravelly fine sandy loam.	GM	A-1	5-20
Skumpah: SrB, SrC2.....	D		>5	0-60	Silty clay loam....	CL-ML or ML	A-4	0
Skylick: SSD, SSF.....	C		3.5->5	0-27 27-66	Silt loam..... Clay loam and cobbly clay loam.	CL-ML or ML ML	A-4 A-6	0 5-20
Snake Hollow: StB.....	B		>5	0-60	Gravelly sandy loam.	SC, SC- SM, GC, GM or GC- GM	A-2 or A-1	0
Tingey: TGG, TGH.....	B		3.5->5	0-60	Stony clay loam or stony sandy clay loam.	CL or SC	A-6	10-25
Toehead: ToB, ToC.....	C		>5	0-60	Silty clay loam or clay loam.	CL	A-6	0
Toehead variant: TSD.....	B		>5	0-60	Silt loam.....	ML-CL or ML	A-4	0
Torrifluvents and Torriorthents, stony: TT. No reliable estimates; material too variable.								

See footnotes at end of table.

significant in engineering—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plastic- ity index	Permea- bility	Avail- able water capacity	Reaction	Salinity	Shrink- swell potential
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)							
				<i>Percent</i>		<i>Inches per hour</i>	<i>Inches per inch of soil</i>	<i>pH</i>		
55-70	50-65	35-50	20-35	20-35	0-5	6.0-20	0.09-0.13	7.9-9.0	None.....	Low.
90-100	80-100	65-95	60-75	25-35	5-10	0.6-2.0	0.13-0.18	7.9-9.0	None.....	Low.
45-65	35-55	25-50	15-30	20-30	5-10	6.0-20	0.04-0.08	7.9-9.0	None.....	Low.
60-95	50-90	45-80	35-50	25-35	5-10	0.6-2.0	0.11-0.15	6.6-9.0	None.....	Low.
80-100	75-95	70-90	55-70	25-35	5-10	0.6-2.0	0.13-0.17	7.4-9.0	None.....	Low.
70-95	65-90	60-85	55-80	30-40	10-20	0.2-0.6	0.11-0.15	6.6-9.0	None.....	Moderate.
-----	100	90-100	85-95	35-45	15-25	0.06-0.2	0.14-0.20	7.9-9.5	Slight.....	High.
35-60	25-50	20-45	10-25	20-30	NP-5	6.0-20	0.05-0.09	7.9-9.5	None.....	Low.
-----	100	90-100	85-95	25-35	5-10	0.2-0.6	0.02-0.04	7.9-9.5	Moderate to very strong.	Low.
-----	100	90-100	70-85	25-35	5-10	0.6-2.0	0.14-0.20	6.1-7.8	None.....	Low.
80-95	75-90	70-85	60-80	35-40	10-15	0.06-0.2	0.14-0.20	6.1-7.8	None.....	Moderate.
60-75	55-70	40-60	15-35	20-30	5-10	2.0-6.0	0.06-0.10	6.6-7.8	None.....	Low.
75-95	70-90	65-80	45-60	30-40	10-15	0.2-0.6	0.10-0.14	6.1-8.4	None.....	Moderate.
100	95-100	90-100	75-90	30-40	10-15	0.2-0.6	0.14-0.20	7.4-8.4	None.....	Moderate.
100	95-100	90-100	70-90	25-35	5-10	0.6-2.0	0.14-0.20	7.4-8.4	None.....	Low.

TABLE 4.—Estimated soil properties

Soil series and map symbols	Hydro- logic group- ing	Depth to sea- sonally high water table ¹	Depth to bedrock	Depth from surface	Dominant USDA texture	Classification		Per- cent cobble (>3.0 inches)
						Unified	AASHTO	
		<i>Inches</i>	<i>Feet</i>	<i>Inches</i>				
Toze: TVD.....	B	-----	>5	0-60	Gravelly silt loam and gravelly very fine sandy loam.	GM	A-4	5-15
Wales: WAC.....	B	0-60	>5	0-60	Loam.....	CL-ML	A-4	0
WcA, WcB.....	B	0-60	>5	0-40	Silty clay loam and gravelly clay loam.	CL or ML	A-6	0
				40-60	Very gravelly sandy loam and very gravelly clay loam.	GC-GM or GM	A-1 or A-2	5-15
Wallsburg: WDE, WEG.....	D	-----	1-1.7	0-17	Very stony loam and very cobbly clay.	GC	A-6 or A-2	30-50
				17	Igneous bed- rock.			
Watkins Ridge: WGD, WhB.....	B	-----	>5	0-60	Silt loam.....	ML or CL- ML	A-4	0-5
Woodrow: WoA, WoC2.....	B	-----	>5	0-60	Silty clay loam and clay loam.	CL or ML	A-6 or A-7	0
Xerofluvents and Fluvaquents: XE. Too variable to rate.								
Xerofluvents and Fluvaquents, saline: XF. Too variable to rate.								
Yeates Hollow: YHE.....	C	-----	3.5->5	0-10	Stony silt loam and stony silty clay loam.	SC or CL	A-6	5-25
				10-20	Stony clay.....	CH	A-7	25-35
				20-60	Very stony clay.	GC or GM	A-2	50-70
*Zeesix: ZSE, ZTE..... For Toze part of ZTE, see Toze series.	C	-----	3.5->5	0-13	Stony silt loam and gravelly silty clay loam.	CL, SC	A-6	0-5
				13-60	Very cobbly clay and very cobbly clay loam.	GC	A-4 or A-2	15-30

¹ Dashes in this column mean that there was no water table within the depth of observation, which is 5 feet, unless limited by bedrock.

² Shale at a depth of 40 inches in AHE2.

³ 30-60 inches in AoB, AnB.

⁴ Nonplastic.

⁵ 0.02-0.04 in AnB.

significant in engineering—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plastic- ity index	Permea- bility	Avail- able water capacity	Reaction	Salinity	Shrink- swell potential
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)							
60-75	55-70	50-65	40-50	Percent 20-30	NP-5	Inches per hour 0.6-2.0	Inches per inch of soil 0.10-0.14	pH 7.4-9.5	None.....	Low.
95-100	90-100	75-95	55-75	25-35	5-10	0.6-2.0	0.13-0.19	7.4-9.0	None.....	Low.
80-100	70-100	65-95	60-90	35-40	10-15	0.6-2.0	0.14-0.20	7.4-9.0	None.....	Moderate.
35-60	30-55	20-40	20-35	15-25	NP-5	2.0-6.0	0.05-0.09	7.4-9.0	None.....	Low.
45-70	40-65	30-65	25-50	30-40	10-20	0.6-2.0	0.06-0.10	6.1-7.8	None.....	Moderate.
80-100	70-100	65-100	50-90	25-35	5-10	0.6-2.0	0.14-0.20	7.4-9.0	None.....	Low.
-----	-----	100	90-100	35-45	10-20	0.2-0.6	0.14-0.20	7.9-9.0	Slight.....	Moderate.
75-85	70-80	60-70	35-60	30-40	10-15	0.6-2.0	0.12-0.18	5.1-7.3	None.....	Moderate.
90-100	85-95	75-95	60-75	70-80	40-50	0.06-0.2	0.10-0.14	5.1-7.3	None.....	High.
45-55	35-45	30-45	25-35	50-60	20-30	0.06-0.2	0.05-0.10	5.1-7.3	None.....	Moderate.
75-95	60-85	55-80	45-75	25-35	10-15	0.6-2.0	0.14-0.20	6.6-9.0	None.....	Moderate.
40-70	35-65	30-60	25-50	35-45	15-25	0.6-2.0	0.09-0.13	6.6-9.0	None.....	Moderate.

* 8.5-9.5 in AnB.

† 40-60 inches in DrB.

* ODD has shale at a depth of 40-60 inches.

* 40-60 inches in Sn.

TABLE 5.—Engineering

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil that may that appear in

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfill ¹	Local roads and streets
*Abcal: Aa, Ab, Ac..... For Cache part of Ac, see Cache series.	Severe: water table at depth of 0 to 40 inches; slow permeability.	Severe: water table at depth of 0 to 40 inches.	Severe: water table at depth of 0 to 40 inches; clay.	Severe: water table at depth of 0 to 40 inches; high shrink-swell potential.	Severe: water table at depth of 0 to 40 inches.	Severe: poorly drained; high shrink-swell potential.
Adel: ADG.....	Severe: slope..	Severe: slope...	Severe: slope...	Severe: slope...	Severe: slope...	Severe: slope...
Amtoft: ² AEE, AFG2....	Severe: shallow over bedrock.	Severe: shallow over bedrock; moderately rapid permeability.	Severe: shallow over bedrock; stones.	Severe: shallow over bedrock; stones.	Severe: shallow over bedrock; moderately rapid permeability.	Severe: shallow over bedrock.
Anco: Ag.....	Severe: water table at depth of 30 to 60 inches; moderately slow permeability.	Severe: water table at depth of 30 to 60 inches.	Moderate: water table at depth of 30 to 60 inches.	Moderate: water table at depth of 30 to 60 inches; moderate shrink-swell potential.	Severe: water table at depth of 30 to 60 inches.	Severe: susceptible to frost action.
*Ant Flat: AHD, AHE2, AkC, ALD. For Borvant part of ALD, see Borvant series.	Severe: slow permeability.	Moderate if slope is less than 7 percent, severe if more than 7.	Severe: texture; some slopes more than 15 percent; shallow over bedrock.	Severe: high shrink-swell potential.	Severe: texture.	Severe: susceptible to frost action; high shrink-swell potential.
*Arapien: AmB, AmC2, AmD2, AnB, AoB, ApC2, ARD. For Calita part of ARD, see Calita series.	Moderate: moderate permeability. Severe for AoB, AnB: water table at depth of 30 to 60 inches.	Moderate: moderate permeability. Severe for AoB, AnB: water table at depth of 30 to 60 inches.	Slight. Moderate for AoB, AnB: water table at depth of 30 to 60 inches. Moderate for AmD2: slope.	Slight to moderate; ApC2 has moderate shrink-swell potential.	Severe: moderate permeability; water table at depth of 30 to 60 inches in AoB and AnB.	Moderate: susceptible to frost action; AoB and AnB have water table at depth of 30 to 60 inches.
*Atepic: ³ ASE2, ATF, AV For Badland part of AV, see Badland series.	Severe: shallow over shale; slow permeability.	Severe: shallow over shale.	Severe: shallow over shale.	Severe: shallow over shale.	Severe: shallow over shale.	Severe: susceptible to frost action; shallow over bedrock.
Atepic variant: AUF.....	Severe: shallow over shale; slow permeability.	Severe: shallow over shale.	Severe: shallow over shale.	Severe: shallow over shale.	Severe: shallow over shale.	Severe: susceptible to frost action; shallow over bedrock.
Badland: BA.....	Severe: slope..	Severe: slope...	Severe if slope is more than 15 percent.	Severe: slope..	Severe: slope...	Severe: slope..
*Bagard: BCE, BDE..... For Sanpitch part of BDE, see Sanpitch series.	Severe: slope; slow permeability.	Severe: slope...	Severe: stones; some slopes more than 15 percent.	Severe: slope; cobbly.	Severe: texture; difficult to work.	Moderate: slope; moderate shrink-swell potential. Severe if slope is more than 15 percent.

See footnotes at end of table.

interpretations

have different properties and limitations. For this reason it is necessary to follow carefully the instructions for referring to other series the first column]

Suitability as source of—			Soil features affecting—			
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Dikes, levees, and other embankments	Drainage for crops and pasture	Irrigation
Poor: water table at depth of 0 to 60 inches; CH or MH material; high shrink-swell potential.	Unsuited.....	Poor: water table at depth of 0 to 40 inches; saline; clay.	Water table at depth of 0 to 40 inches.	Water table at depth of 0 to 40 inches; high shrink-swell potential; high compressibility; low to medium shear strength.	Not feasible: no outlets.	Not needed: water table at depth of 0 to 40 inches.
Poor: slope.....	Unsuited.....	Poor: slope.....	Slope.....	Medium to low shear strength; medium susceptibility to piping.	Not needed.....	Not feasible: steep.
Fair: susceptible to frost action; shallow over bedrock.	Unsuited.....	Poor: slope; cobbly.	Shallow over bedrock.	Less than 20 inches deep over bedrock; stones.	Not needed.....	Shallow over bedrock; steep.
Poor: susceptible to frost action.	Unsuited.....	Fair: silty clay loam.	Water table at depth of 30 to 60 inches.	Medium susceptibility to piping; medium compressibility; medium to low shear strength.	Moderately slow permeability.	Water table at depth of 30 to 60 inches; moderately slow permeability.
Poor: susceptible to frost action; high shrink-swell potential.	Unsuited.....	Fair above a depth of 10 to 20 inches; poor below: silty clay or clay loam.	Slope.....	Medium to low shear strength; fair to poor compactibility; high compressibility.	Not needed.....	Steep slope; severe erosion hazard; slow permeability.
Poor: susceptible to frost action.	Unsuited.....	Good above a depth of 10 to 14 inches, poor below: high content of lime	Moderate permeability; water table in AoB and AnB at depth of 30 to 60 inches.	Water table at depth of 30 to 60 inches; medium to low shear strength; fair to good compactibility; medium to low compressibility.	Moderate permeability in AoB and AnB.	Erosion hazard if slope is more than 3 percent; drainage needed in AoB and AnB.
Poor: susceptible to frost action; shallow over bedrock.	Unsuited.....	Poor: shallow over shale; coarse fragments.	Less than 20 inches deep over shale.	Medium to low shear strength; poor to fair compactibility; medium susceptibility to piping; shallow over rock.	Not needed.....	Shallow over shale.
Poor: susceptible to frost action; shallow over bedrock.	Unsuited.....	Poor: shallow over shale; coarse fragments.	Shallow over shale.	Shallow over rock; poor to fair compactibility; low susceptibility to piping.	Not needed.....	Shallow over shale.
Poor: slope.....	Unsuited.....	Poor: slope.....	Slope.....	Slope.....	Not needed.....	Not feasible: slope.
Fair: susceptible to frost action; moderate shrink-swell potential. Poor if slope is more than 25 percent.	Poor: GC material.	Poor: too many stones and cobbles.	Slope.....	Low to medium compressibility; cobbly; medium to high shear strength.	Not needed.....	Not feasible: very stony; steep slope.

TABLE 5.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfill ¹	Local roads and streets
Beek: Be-----	Severe: water table at depth of 20 to 60 inches.	Severe: water table at depth of 20 to 60 inches.	Severe: water table at depth of 20 to 60 inches.	Moderate: water table at depth of 20 to 60 inches; moderate shrink-swell potential.	Severe: water table at depth of 20 to 60 inches.	Severe: susceptible to frost action; water table at depth of 20 to 60 inches.
*Bezzant: BFD, BGE, BH. For Gappmayer part of BH, see Gappmayer series.	Severe: slope..	Severe: slope..	Slight if slope is less than 8 percent, moderate if 8 to 15, severe if more than 15.	Slight if slope is less than 8 percent, moderate if 8 to 15, severe if more than 15.	Moderate if slope is less than 25 percent, severe if more than 25.	Moderate if slope is less than 15 percent, severe if more than 15.
Billings: Bm-----	Severe: slow permeability.	Slight-----	Slight-----	Moderate: moderate shrink-swell potential.	Moderate: texture; difficult to work.	Severe: susceptible to frost action.
Birdow: BnB, BnC, BoB..	Moderate: moderate permeability.	Moderate: moderate permeability.	Slight-----	Slight-----	Slight-----	Severe: susceptible to frost action.
*Borvant: ⁴ BRD2, BSE2, BTC, BUD2. For Lodar part of BUD2, see Lodar series. For Doyce part of BTC, see Doyce series. For Bagard part of BSE2, see Bagard series.	Severe: shallow over indurated hardpan.	Severe: shallow over hardpan; moderately rapid permeability.	Severe: shallow over hardpan.	Severe: shallow over hardpan.	Severe: shallow over hardpan; moderately rapid permeability.	Severe: shallow over hardpan.
Bradshaw: BVG-----	Severe: slope..	Severe: slope; moderately rapid permeability.	Severe: slope..	Severe: slope..	Severe: slope; moderately rapid permeability.	Severe: slope..
Cache----- Mapped only with Abcal soil.	Severe: water table at depth of 20 to 40 inches; slow permeability.	Severe: water table at depth of 20 to 40 inches.	Severe: water table at depth of 20 to 40 inches.	Severe: water table at depth of 20 to 40 inches; high shrink-swell potential.	Severe: water table at depth of 20 to 40 inches.	Severe: water table at depth of 20 to 40 inches; poorly drained; high shrink-swell potential.
Calita: CaB, CaC-----	Moderate: moderate permeability.	Moderate: moderate permeability; slope.	Slight-----	Slight-----	Slight-----	Fair: susceptible to frost action.
Canburn: Cb-----	Severe: water table at depth of 0 to 50 inches; moderately slow permeability.	Severe: water table at depth of 0 to 50 inches.	Severe: water table at depth of 0 to 50 inches.	Severe: water table at depth of 0 to 50 inches.	Severe: water table at depth of 0 to 50 inches.	Severe: susceptible to frost action.

See footnotes at end of table.

interpretations—Continued

Suitability as source of—			Soil features affecting—			
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Dikes, levees, and other embankments	Drainage for crops and pasture	Irrigation
Poor: susceptible to frost action.	Unsuited-----	Fair to a depth of 25 inches, poor below.	Water table at depth of 20 to 60 inches.	Water table at depth of 20 to 60 inches; medium to low shear strength; medium compressibility.	Moderately slow permeability.	Water table at depth of 20 to 60 inches.
Fair if slope is less than 25 percent, poor if more than 25.	Poor: too many fines; cobbly; GM or GC material.	Poor: too many cobbles and coarse fragments.	Moderate: permeability; slope.	Medium to low susceptibility to piping; cobbly.	Not needed-----	Stony; steep slope.
Poor: susceptible to frost action.	Unsuited-----	Fair: silty clay loam.	Gypsum-----	Low susceptibility to piping; medium to low shear strength; medium compressibility.	Not needed-----	Erosion hazard if slope is more than 3 percent.
Poor: susceptible to frost action.	Unsuited-----	Good-----	Moderate permeability.	Medium to low shear strength; fair to good compactibility; medium susceptibility to piping.	Not needed-----	Erosion hazard if slope is more than 3 percent.
Moderate: susceptible to frost action.	Unsuited-----	Poor: too many cobbles; shallow over hardpan.	Shallow over hardpan.	Fair to good compactibility; medium to low susceptibility to piping; cobbly.	Not needed-----	Shallow over hardpan.
Poor: slope-----	Poor: too many fines; stony; SM or GM material.	Poor: slope; stones and cobbles.	Slope; moderately rapid permeability.	Fair to good compactibility; very stony; medium susceptibility to piping.	Not needed-----	Steep slope.
Poor: water table at depth of 20 to 40 inches; high shrink-swell potential.	Unsuited-----	Poor: poorly drained.	Very strongly saline; water table at depth of 20 to 40 inches.	Water table at depth of 20 to 40 inches; low shear strength; high compressibility; poor to fair compactibility.	Not feasible: no outlets; slow permeability.	High salt content; slow permeability.
Fair: susceptible to frost action.	Unsuited-----	Good above 10 to 14 inches, poor below; high content of lime.	Moderate permeability.	Medium to low shear strength; fair compactibility; medium susceptibility to piping.	Not needed-----	Erosion hazard if slope is more than 4 percent.
Poor: water table at depth of 0 to 50 inches; susceptible to frost action.	Unsuited-----	Poor: water table at depth of 0 to 50 inches; poorly drained.	Water table at depth of 0 to 50 inches.	Water table at depth of 0 to 50 inches; medium to low shear strength; fair to good compactibility; medium compressibility; low susceptibility to piping.	Moderately slow permeability; flooding in places.	Water table at depth of 0 to 50 inches.

TABLE 5.—Engineering

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfill ¹	Local roads and streets
Centerfield: CcB, CcC2---	Slight ⁵ -----	Severe: rapid permeability.	Severe: very gravelly below a depth of 20 inches.	Moderate: shrink-swell potential.	Severe: rapid permeability; gravel.	Severe: susceptible to frost action in upper 20 inches. Slight below a depth of 20 inches.
Cheadle: ² CDG-----	Severe: shallow over bedrock; slope.	Severe: shallow over bedrock; slope; rapid permeability.	Severe: shallow over bedrock.	Severe: shallow over bedrock.	Severe: shallow over bedrock; slope; rapid permeability.	Severe: slope; shallow over bedrock.
*Chipman: Ch, Cm----- For Poganeab part of Cm, see Poganeab variant.	Severe: water table at depth of 10 to 30 inches; moderately slow permeability.	Severe: water table at depth of 10 to 30 inches.	Severe: water table at depth of 10 to 30 inches.	Severe: water table at depth of 10 to 30 inches.	Severe: water table at depth of 10 to 30 inches.	Severe: poorly drained; highly susceptible to frost action; water table at depth of 10 to 30 inches.
Clegg: CNC-----	Severe: moderately slow permeability.	Moderate: slope.	Slight-----	Moderate: moderate shrink-swell potential.	Moderate: texture; difficult to work.	Severe: susceptible to frost action.
Collard: CoC, CRD-----	Slight if slope is less than 8 percent, moderate if 8 to 15, severe if more than 15. ⁵	Severe: rapid permeability; slope.	Severe: very gravelly and cobbly.	Slight if slope is less than 8 percent, moderate if 8 to 15, severe if more than 15.	Severe: rapid permeability; gravelly.	Slight-----
Crestline: CsC-----	Slight-----	Severe: moderately rapid permeability.	Slight-----	Slight-----	Severe: moderately rapid permeability.	Moderate: susceptible to frost action.
Cryoborolls: CU. No interpretations. Material too variable.						
*Daybell: DAG, DBG----- For Flygare part of DBG, see Flygare series.	Severe: slope--	Severe: slope; rapid permeability.	Severe: slope; very gravelly.	Severe: slope--	Severe: slope; rapid permeability.	Severe: slope--
*Deer Creek: DCD, DED, DEE, DFF. For Mower part of DFF, see Mower series.	Severe: slow permeability.	Moderate if slope is less than 7 percent, severe if more than 7.	Moderate: gravel; cobbles. Severe if slope is more than 15 percent.	Moderate if slope is less than 15 percent; moderate shrink-swell potential. Severe if slope is more than 15 percent.	Severe: texture; difficult to work.	Severe: high shrink-swell potential; susceptible to frost action.

See footnotes at end of table.

interpretations—Continued

Suitability as source of—			Soil features affecting—			
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Dikes, levees, and other embankments	Drainage for crops and pasture	Irrigation
Poor above a depth of 20 inches; susceptible to frost action. Good below a depth of 20 inches.	Unsuited above depth of 20 inches. Fair below a depth of 20 inches; too many fines; GM-GP material; cobbles.	Fair above a depth of 20 inches, poor below; too many coarse fragments.	Rapid permeability.	Low susceptibility to piping; medium to high permeability; good compactibility.	Not needed.....	Low available water capacity; rapid permeability.
Poor: steep slope; shallow over bedrock.	Poor: GM material; too many fines.	Poor: too many coarse fragments.	Slope; shallow over bedrock.	Very cobbly; shallow over bedrock.	Not needed.....	Steep slope.
Poor: water table at depth of 10 to 30 inches; susceptible to frost action.	Unsuited.....	Poor: water table at depth of 10 to 30 inches; poorly drained.	Water table at depth of 10 to 30 inches.	Water table at depth of 10 to 30 inches; medium shear strength; fair to good compactibility; medium compressibility; low susceptibility to piping.	Moderately slow permeability.	Water table at depth of 10 to 30 inches.
Poor: susceptible to frost action.	Unsuited.....	Good to a depth of 16 inches, fair below.	Moderate permeability; slope.	Low susceptibility to piping; medium to low shear strength; fair compactibility; low to medium compressibility.	Not needed.....	Erosion hazard if slope is more than 6 percent.
Good.....	Poor above a depth of 20 inches, good below; cobbly.	Poor: coarse fragments.	Very rapid permeability.	High permeability; very cobbly; high shear strength.	Not needed.....	Low available water capacity; gravelly or cobbly.
Fair: susceptible to frost action.	Unsuited.....	Fair: texture; coarse fragments.	Moderately rapid permeability.	High susceptibility to piping; medium shear strength; fair to good compactibility.	Not needed.....	Erosion hazard if slope is more than 2 percent.
Poor: slope ⁶	Poor: GM material.	Poor: too many coarse fragments.	Slope; rapid permeability.	Very cobbly; high to medium shear strength; fair to good compactibility.	Not needed.....	Very steep slope.
Poor: high shrink-swell potential; susceptible to frost action.	Unsuited.....	Poor: coarse fragments; texture.	Slope.....	Medium to low shear strength; fair compactibility; high compressibility; cobbly.	Not needed.....	Slow permeability; steep slope; stony.

TABLE 5.—Engineering

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfill ¹	Local roads and streets
Denmark: DgC-----	Severe: shallow over hardpan.	Severe: shallow over hardpan.	Severe: shallow over hardpan.	Severe: shallow over hardpan.	Severe: shallow over hardpan.	Severe: shallow over hardpan.
Donnardo: DhD, DKD, DLD.	Slight if slope is less than 8 percent, moderate if 8 to 15, severe if more than 15. ⁵	Severe: rapid permeability.	Severe: very stony.	Severe: stones.	Severe: rapid permeability; cobbly.	Moderate: susceptible to frost action.
Doyce: DoB, DoC, DrB..	Severe: moderately slow permeability; water table in DrB at depth of 40 to 60 inches.	Slight. Moderate for DrB: water table at depth of 40 to 60 inches.	Slight. Moderate for DrB: water table at depth of 40 to 60 inches.	Moderate: moderate shrink-swell potential.	Slight. Moderate for DrB: water table at depth of 40 to 60 inches.	Moderate to severe: susceptible to frost action.
Dyreg: Ds, Dy-----	Severe: water table at depth of 30 to 60 inches; slow permeability.	Severe: water table at depth of 30 to 60 inches.	Severe: texture; water table at depth of 30 to 60 inches; somewhat poorly drained.	Severe: high shrink-swell potential.	Severe: texture; water table at depth of 30 to 60 inches.	Severe: susceptible to frost action; high shrink-swell potential.
Ephraim: Ep-----	Severe: water table at depth of 30 to 60 inches; moderately slow permeability.	Moderate to severe: water table at depth of 30 to 60 inches.	Moderate: water table at depth of 30 to 60 inches.	Moderate: moderate shrink-swell potential.	Severe: water table at depth of 30 to 60 inches.	Severe: susceptible to frost action.
Fluvaquents: FN. No interpretations. Material too variable.						
Flygare----- Mapped only with Daybell soil.	Severe: slope..	Severe: slope..	Severe: very gravelly; steep slope.	Severe: slope..	Severe: slope..	Severe: slope; susceptible to frost action.
*Fontreen: FOD, FRE2, FRG2, FSD2. For Borvant part of FSD2, see Borvant series.	Slight if slope is less than 8 percent, moderate if 8 to 15, severe if more than 15.	Severe: moderately rapid permeability.	Severe: very cobbly; steep slope.	Slight if slope is less than 8 percent, moderate if 8 to 15, severe if more than 15.	Severe: moderately rapid permeability.	Moderate: susceptible to frost action; 8 to 15 percent slope. Severe if slope is more than 15 percent.
*Freedom: FTD----- For Amtoft part of FTD, see Amtoft series.	Severe: moderately slow permeability.	Slight if slope is less than 2 percent, moderate if 2 to 7.	Slight if slope is less than 8 percent, moderate if 8 to 15.	Moderate: moderate shrink-swell potential.	Moderate: silty clay loam.	Severe: susceptible to frost action.

See footnotes at end of table.

interpretations—Continued

Suitability as source of—			Soil features affecting—			
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Dikes, levees, and other embankments	Drainage for crops and pasture	Irrigation
Fair: susceptible to frost action.	Poor: SM or ML material.	Poor: shallow over hardpan; gravelly.	Shallow over hardpan.	Fair compactibility; medium susceptibility to piping; shallow over bedrock.	Not needed-----	Low available water capacity; shallow over hardpan.
Fair: susceptible to frost action; cobbly.	Unsuited-----	Poor: too many cobbles and stones.	Rapid permeability.	Fair to good compactibility; medium to low shear strength; stones.	Not needed-----	Low available water capacity; stony; steep slope.
Fair: susceptible to frost action.	Unsuited-----	Fair: sandy clay loam to a depth of about 32 inches, gravelly and stony below.	Moderately slow permeability.	Medium to low shear strength; fair compactibility; medium compressibility; DrB has water table at depth of 40 to 60 inches.	Moderately slow permeability; DrB has hardpan below 40 inches in places.	Erosion hazard if slope is more than 4 percent; water table in DrB at depth of 40 to 60 inches.
Poor: susceptible to frost action; water table at depth of 30 to 60 inches; high shrink-swell potential.	Unsuited-----	Poor: texture; silty clay or heavy silty clay loam.	Water table at depth of 30 to 60 inches.	Water table at depth of 30 to 60 inches; medium to low shear strength; fair compactibility; medium compressibility.	Slow permeability.	Slow permeability; water table at depth of 30 to 60 inches.
Poor: susceptible to frost action; water table at depth of 30 to 60 inches.	Unsuited-----	Fair: silty clay loam.	Water table at depth of 30 to 60 inches.	Water table at depth of 30 to 60 inches; medium to low shear strength; fair compactibility; medium compressibility.	Moderately slow permeability.	Moderately slow permeability; water table at depth of 30 to 60 inches.
Poor: slope ^a -----	Unsuited-----	Poor: slope; gravelly and cobbly.	Slope; rapid permeability.	Very cobbly; low to medium susceptibility to piping; medium shear strength; fair to good compactibility.	Not needed-----	Very steep slope.
Fair if slope is less than 25 percent, poor if more than 25; susceptible to frost action.	Poor: fines cobbles; GM or GC material.	Poor: cobbles and stones.	Moderately rapid permeability; slope.	Good to fair compactibility; very cobbly; medium shear strength.	Not needed-----	Steep slope; very cobbly.
Poor: susceptible to frost action; shrink-swell potential.	Unsuited-----	Fair: silty clay loam.	-----	Medium susceptibility to piping; medium to low shear strength; fair compactibility; medium compressibility.	Not needed-----	Erosion hazard if slope is more than 4 percent.

TABLE 5.—Engineering

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfill ¹	Local roads and streets
Gappmayer..... Mapped only with Bezzant soil.	Severe: slope..	Severe: slope; rapid permeability.	Severe: very gravelly; steep slope.	Severe: slope..	Severe: slope; rapid permeability.	Severe: slope..
Genola: GeB, GeC2, GeD2, GkB.	Moderate: moderate permeability.	Moderate if slope is less than 7 percent, severe if more than 7.	Slight.....	Moderate: moderate shrink-swell potential.	Slight	Moderate: moderate shrink-swell potential; susceptible to frost action.
Gothic: GOF2.....	Severe: slow permeability; slope; stones.	Severe: slope; stones.	Severe: texture; hard when dry; stones.	Severe: high shrink-swell potential; stones.	Severe: texture; stones.	Severe: susceptible to frost action; slope; high shrink-swell potential.
Green River: Gr.....	Severe: water table at depth of 30 to 60 inches.	Moderate to severe: water table at depth of 30 to 60 inches.	Moderate: water table at depth of 30 to 60 inches.	Slight.....	Severe: water table at depth of 30 to 60 inches.	Moderate: susceptible to frost action.
Gullied land: Gu. No interpretations. Material too variable.						
Harding: Ha.....	Severe: slow permeability.	Slight to moderate: saline-alkali; unstable.	Slight to moderate: texture; saline-alkali.	Moderate: moderate to high shrink-swell potential.	Moderate: texture; difficult to work.	Severe: susceptible to frost action; moderate to high shrink-swell potential.
Harkers: HED, HKE....	Severe: slow permeability.	Severe: slope..	Severe: texture; hard when dry.	Severe: high shrink-swell potential.	Severe: texture; difficult to work.	Severe: high shrink-swell potential; susceptible to frost action.
Keigley: KcB.....	Severe: moderately slow permeability.	Moderate: slope.	Slight.....	Moderate: moderate shrink-swell potential.	Moderate: texture; difficult to work.	Severe: susceptible to frost action.
*Kitchell: KEG, KM..... For Mower part of KM, see Mower series.	Severe: slope..	Severe: moderately rapid permeability; slope.	Severe: very cobbly; slope; stones.	Severe: slope; stones.	Severe: slope; moderately rapid permeability; stones.	Severe: slope..

See footnotes at end of table.

interpretations—Continued

Suitability as source of—			Soil features affecting—			
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Dikes, levees, and other embankments	Drainage for crops and pasture	Irrigation
Poor: slope-----	Unsuited-----	Poor: slope; gravelly and cobbly.	Slope; rapid permeability.	Good compactibility; very cobbly; medium shear strength.	Not needed-----	Very steep slope.
Poor: susceptible to frost action.	Unsuited-----	Good. Poor for GkB: salinity.	Moderate permeability.	Medium to low susceptibility to piping; medium to low shear strength; fair to good compactibility; medium compressibility.	Not needed-----	Erosion hazard if slope is more than 2 percent.
Poor: susceptible to frost action; high shrink-swell potential.	Unsuited-----	Poor: clay loam and cobbly clay.	Slope-----	Medium shear strength; fair to poor compactibility; high to medium compressibility.	Not needed-----	Steep slope.
Fair: water table at depth of 30 to 60 inches; susceptible to frost action.	Unsuited-----	Good above a depth of 16 inches, fair below; water table at depth of 30 to 60 inches.	Water table at depth of 30 to 60 inches; moderate permeability.	Water table at depth of 30 to 60 inches; medium to low shear strength; medium susceptibility to piping; low to medium compressibility.	Moderate permeability.	Water table at depth of 30 to 60 inches.
Poor: susceptible to frost action; moderate to high shrink-swell potential.	Unsuited-----	Poor: saline-alkali; silty clay.	Slow permeability; unstable banks.	Medium to low shear strength; medium compressibility; fair to good compactibility.	Not needed-----	Strongly saline-alkali.
Poor: high shrink-swell potential; highly susceptible to frost action.	Unsuited-----	Fair above a depth of 12 inches, poor below; cobbly and gravelly.	Slope-----	Medium to low shear strength; fair to poor compactibility; high to medium compressibility.	Not needed-----	Slow permeability; steep slope.
Poor: susceptible to frost action.	Unsuited-----	Fair: silty clay loam.	Moderately slow permeability.	Medium to low shear strength; fair to good compactibility; medium compressibility.	Not needed-----	Moderately slow permeability.
Poor: slope; fair as a borrow area.	Unsuited-----	Poor: slope; cobbles; stones.	Slope: moderately rapid permeability.	Good compactibility; medium shear strength; very cobbly.	Not needed-----	Steep slope.

TABLE 5.—Engineering

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfill ¹	Local roads and streets
Kjar: Kp-----	Severe: water table at depth of 0 to 10 inches.	Severe: water table at depth of 0 to 10 inches.	Severe: water table at depth of 0 to 10 inches.	Severe: water table at depth of 0 to 10 inches.	Severe: water table at depth of 0 to 10 inches.	Severe: water table at depth of 0 to 10 inches; poorly drained; susceptible to frost action.
Linoyer: LdB, LdC2-----	Moderate: moderate permeability.	Moderate: moderate permeability; slope.	Slight-----	Slight-----	Slight-----	Severe: susceptible to frost action.
*Lisade: LeB, LeC2, LFC2. For Sanpete part of LFC2, see Sanpete series.	Slight-----	Severe: moderately rapid permeability.	Slight to moderate: gravel.	Slight-----	Severe: moderately rapid permeability.	Moderate: susceptible to frost action.
*Lizzant: LGE, LHD, LKG, LLE, LMF, LNE, LOF. For Clegg part of LLE, see Clegg series. For Sedwell part of LNE, see Sedwell series. For Kitchall part of LOF, see Kitchell series. For Mower part of LMF, see Mower series.	Slight if slope is less than 8 percent, moderate if 8 to 15, severe if more than 15.	Severe: moderately rapid permeability; slope.	Severe: very cobbly; slope.	Slight if slope is less than 8 percent, moderate if 8 to 15, severe if more than 15.	Severe: moderately rapid permeability.	Moderate if slope is 8 to 15 percent, severe if more than 15.
*Lodar: LRE, LSG, LTE, LTG. For Fontreen part of LSG, see Fontreen series.	Severe: shallow over bedrock.	Severe: shallow over bedrock; moderately rapid permeability.	Severe: shallow over bedrock.	Severe: shallow over bedrock.	Severe: shallow over bedrock; moderately rapid permeability.	Severe: shallow over bedrock.
Lundy: LUE-----	Severe: shallow over bedrock.	Severe: shallow over bedrock; moderately rapid permeability.	Severe: shallow over bedrock.	Severe: shallow over bedrock.	Severe: shallow over bedrock; moderately rapid permeability.	Severe: shallow over bedrock.
*Manassa: MA----- For Mellor part of MA, see Mellor series.	Severe: slow permeability.	Slight to moderate: saline-alkali; unstable.	Slight-----	Moderate: moderate shrink-swell potential.	Moderate: texture; difficult to work.	Severe: susceptible to frost action.
Manila: MbC-----	Severe: slow permeability.	Moderate: slope.	Severe: texture; hard when dry.	Severe: high shrink-swell potential.	Severe: texture; difficult to work.	Severe: high shrink-swell potential.

See footnotes at end of table.

interpretations—Continued

Suitability as source of—			Soil features affecting—			
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Dikes, levees, and other embankments	Drainage for crops and pasture	Irrigation
Poor: water table at depth of 0 to 10 inches; susceptible to frost action.	Unsuited.....	Poor: water table at depth of 0 to 10 inches; saline-alkali.	Water table at depth of 0 to 10 inches; moderate permeability.	High susceptibility to piping; not suitable to a depth of 8 inches, medium to low shear strength below; fair to good compactibility; water table at depth of 0 to 10 inches.	Not feasible: no outlets; seasonal flooding.	Water table at depth of 0 to 10 inches; strongly saline.
Poor: susceptible to frost action.	Unsuited.....	Good.....	Moderate permeability.	Medium to low shear strength; fair compactibility; medium compressibility; high susceptibility to piping.	Not needed.....	Erosion hazard if slope is more than 3 percent.
Fair: susceptible to frost action.	Unsuited.....	Fair above a depth of 8 to 10 inches, poor below; high lime content.	Moderately rapid permeability.	High susceptibility to piping; medium shear strength.	Not needed.....	Moderate available water capacity; erosion hazard if slope is more than 3 percent.
Fair if slope is less than 25 percent, poor if more than 25; susceptible to frost action.	Unsuited.....	Poor: too many stones or cobbles.	Moderately rapid permeability; slope.	Very cobbly; medium shear strength; good compactibility.	Not needed.....	Steep slope; very cobbly.
Fair: shallow over bedrock.	Unsuited.....	Poor: cobbles and stones; shallow over bedrock.	Shallow over bedrock.	Shallow over bedrock; very cobbly; good compactibility; medium shear strength.	Not needed.....	Shallow over bedrock; steep slope.
Fair: shallow over bedrock.	Unsuited.....	Poor: cobbles and stones; shallow over bedrock.	Shallow over bedrock.	Shallow over bedrock; fair to good compactibility; medium shear strength.	Not needed.....	Shallow over-bedrock; steep slope.
Poor: susceptible to frost action.	Unsuited.....	Poor: strongly saline-alkali.	Slow permeability; unstable banks.	Medium to low shear strength; fair compactibility; medium compressibility.	Not needed.....	Strongly saline-alkali; slow permeability.
Poor: high shrink-swell potential.	Unsuited.....	Good above depth of 8 to 16 inches, poor below; texture.	Slow permeability; high shrink-swell potential.	Medium to low shear strength; fair to poor compactibility; medium to high compressibility.	Not needed.....	Slow permeability; erosion hazard if slope is more than 5 percent.

TABLE 5.—Engineering

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfill ¹	Local roads and streets
Mayfield: McB, McB2----	Slight-----	Severe: moderately rapid permeability.	Moderate: gravelly.	Slight-----	Severe: moderately rapid permeability.	Moderate: susceptible to frost action.
Mellor: Md, Me-----	Severe: slow permeability.	Slight to moderate: saline-alkali; unstable.	Slight-----	Moderate: moderate shrink-swell potential.	Moderate: texture; difficult to work.	Severe: susceptible to frost action.
*Moroni: MfC, MGD----- For Atepic part of MGD, see Atepic series.	Severe: slow permeability.	Moderate if slope is less than 7 percent, severe if more than 8.	Severe: texture; hard when dry.	Severe: high shrink-swell potential.	Severe: texture; difficult to work.	Severe: high shrink-swell potential; susceptible to frost action.
*Mortenson: MHG, MKG. For Skylick part of MKG, see Skylick series.	Severe: slow permeability; slope.	Severe: slope--	Severe: slope; stony.	Severe: slope; stony.	Severe: slope; stony.	Severe: slope; susceptible to frost action.
Mortenson variant: MLD.	Severe: slow permeability; slope; shallow over bedrock.	Severe: slope--	Moderate if slope is 8 to 15 percent, severe if more than 15.	Moderate if slope is 8 to 15 percent, severe if more than 15.	Severe: shallow over bedrock; texture; slope.	Severe: susceptible to frost action; high shrink-swell potential; slope.
*Mountainville: MmC, MnC, MoC. For Doyce part of MoC, see Doyce series.	Moderate: stones; moderate permeability.	Severe: stony--	Severe: stony--	Severe: stony--	Severe: stony--	Moderate: stones; susceptible to frost action.
Mountainville variant: MrD.	Severe: shallow over hardpan; slow permeability.	Shallow over hardpan.	Severe: shallow over hardpan.	Severe: shallow over hardpan.	Severe: shallow over hardpan.	Severe: shallow over hardpan; high shrink-swell potential.
*Mower: MSD, MTD, MUF2, MVE. For Lundy part of MVE, see Lundy series.	Severe: shallow over bedrock.	Severe: shallow over bedrock; slope.	Severe: shale below a depth of 20 inches.	Moderate: moderate shrink-swell potential; shallow over shale. Severe if slope is more than 15 percent.	Severe: shallow over bedrock.	Severe: susceptible to frost action; shallow over bedrock.
Obrast: ObC, OCD, ODD.	Severe: very slow permeability.	Moderate if slope is less than 7 percent, severe if more than 7.	Severe: texture.	Severe: high shrink-swell potential.	Severe: texture.	Severe: high shrink-swell potential.
*Pavant: ⁴ PaC, PDC----- For Doyce part of PDC, see Doyce series.	Severe: shallow over hardpan.	Severe: shallow over hardpan.	Severe: shallow over hardpan.	Severe: shallow over hardpan.	Severe: shallow over hardpan.	Severe: shallow over hardpan.

See footnotes at end of table.

interpretations—Continued

Suitability as source of—			Soil features affecting—			
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Dikes, levees, and other embankments	Drainage for crops and pasture	Irrigation
Fair: susceptible to frost action.	Unsuited.....	Poor: shale fragments.	Moderately rapid permeability; some gypsum.	Fair to good compactibility; high to medium shear strength.	Not needed.....	Moderate: available water capacity.
Poor: susceptible to frost action.	Unsuited.....	Poor: saline-alkali.	Slow permeability.	Medium susceptibility to piping; medium to low shear strength; fair compactibility; medium compressibility.	Not needed.....	Strongly saline-alkali; moderately slow permeability.
Poor: susceptible to frost action; high shrink-swell potential.	Unsuited.....	Poor: silty clay.	Slow permeability; high shrink-swell potential.	Low shear strength; poor compactibility; high compressibility.	Not needed.....	Erosion hazard if slope is more than 3 percent; susceptible to cracking.
Poor: slope; stones; susceptible to frost action.	Unsuited.....	Poor: slopes; stony.	Slope.....	Medium shear strength; fair to good compactibility; low compressibility; very stony.	Not needed.....	Very steep slope.
Fair: susceptible to frost action. Poor if slope is more than 25 percent.	Unsuited.....	Poor: clay; coarse fragments.	Slope.....	Medium shear strength; fair to good compactibility.	Not needed.....	Steep slope.
Fair: stones; susceptible to frost action.	Unsuited.....	Poor: stony...	Moderate permeability; stony.	Good compactibility; medium susceptibility to piping; medium shear strength.	Not needed.....	Very stony.
Poor: shallow over hardpan; high shrink-swell potential.	Unsuited.....	Poor: stones; shallow over hardpan.	Shallow over hardpan.	Shallow over hardpan; medium shear strength; fair to good compactibility.	Not needed.....	Very stony.
Poor: susceptible to frost action.	Unsuited.....	Fair above the hardpan; clay loam and silty clay loam.	Slope.....	Medium to low shear strength; fair compactibility; medium compressibility; medium susceptibility to piping.	Not needed.....	Steep slope.
Poor: high shrink-swell potential.	Unsuited.....	Poor: silty clay.	Slope; high shrink-swell potential.	Low shear strength; poor compactibility; high compressibility.	Not needed.....	Very slow permeability.
Poor: shallow over hardpan; susceptible to frost action.	Unsuited.....	Fair above a depth of 10 to 20 inches; hardpan below.	Shallow over hardpan.	Shallow over hardpan; medium to low shear strength; fair compactibility; medium compressibility; moderate susceptibility to piping.	Not needed.....	Low available water capacity; shallow over hardpan.

TABLE 5.—Engineering

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfill ¹	Local roads and streets
Peteetneet: Pe.....	Severe: water table at depth of 0 to 60 inches; peat.	Severe: water table at depth of 0 to 60 inches; peat.	Severe: water table at depth of 0 to 60 inches; peat.	Severe: water table at depth of 0 to 60 inches; peat.	Severe: water table at depth of 0 to 60 inches; peat.	Severe: water table at depth of 0 to 60 inches; peat.
Poganeab: Pg, Ph.....	Severe: water table at depth of 0 to 40 inches; moderately slow permeability.	Severe: water table at depth of 0 to 40 inches.	Severe: water table at depth of 0 to 40 inches.	Severe: water table at depth of 0 to 40 inches.	Severe: water table at depth of 0 to 40 inches.	Severe: water table at depth of 0 to 40 inches; susceptible to frost action.
Poganeab variant: Pk....	Severe: water table at depth of 20 to 36 inches; moderately slow permeability.	Severe: water table at depth of 20 to 36 inches.	Severe: water table at depth of 20 to 36 inches.	Moderate: water table at depth of 20 to 36 inches.	Severe: water table at depth of 20 to 36 inches.	Severe: water table at depth of 20 to 36 inches; susceptible to frost action.
Pritchett: PRF, PTE.....	Severe: moderately slow permeability; slope.	Severe: slope..	Severe: slope; stony clay.	Severe: slope; stony.	Severe: slope..	Severe: slope; susceptible to frost action.
*Quaker: QkB, QkC, Qm For Mellor part of Qm, see Mellor series.	Severe: moderately slow permeability.	Slight if slope is less than 2 percent, moderate if 2 to 7.	Slight.....	Moderate: moderate shrink-swell potential.	Moderate: texture.	Severe: susceptible to frost action.
Rapho: RaC, RaD.....	Slight.....	Severe: rapid permeability.	Moderate: gravel.	Slight.....	Severe: rapid permeability.	Slight.....
Ravola: RiB, RiC, RiC2.	Moderate: moderate permeability.	Moderate: moderate permeability.	Slight.....	Slight to moderate; gypsum in some areas.	Slight.....	Moderate: susceptible to frost action.
Rock land: RO. No interpretations. Material too variable.						
Sanpete: SaC, SbD2, SCE2.	Slight if slope is less than 8 percent, moderate if 8 to 15, severe if more than 15. ⁵	Severe: rapid permeability.	Severe: very gravelly; slope.	Slight if slope is less than 8 percent, moderate if 8 to 15, severe if more than 15.	Severe: rapid permeability.	Slight if slope is less than 8 percent, moderate if 8 to 15, severe if more than 15.

See footnotes at end of table.

interpretations—Continued

Suitability as source of—			Soil features affecting—			
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Dikes, levees, and other embankments	Drainage for crops and pasture	Irrigation
Unsuited.....	Unsuited.....	Unsuited.....	Water table at depth of 0 to 60 inches; organic soil.	Unsuited.....	Not feasible: no outlets.	Water table at depth of 0 to 60 inches.
Poor: water table at depth of 0 to 40 inches; susceptible to frost action.	Unsuited.....	Poor: water table at depth of 0 to 40 inches; poorly drained.	Water table at depth of 0 to 40 inches.	Water table at depth of 0 to 40 inches; medium to low shear strength; fair compactibility; medium compressibility; high susceptibility to piping.	Moderately slow permeability; seasonal flooding in places.	Water table at depth of 0 to 40 inches.
Poor: water table at depth of 20 to 36 inches; susceptible to frost action.	Unsuited.....	Poor: poorly drained; water table at depth of 20 to 36 inches.	Water table at depth of 20 to 36 inches.	Water table at depth of 20 to 36 inches; medium to low shear strength; fair compactibility; medium compressibility; high susceptibility to piping.	Moderately slow permeability.	Water table at depth of 20 to 36 inches.
Poor: slope; susceptible to frost action.	Unsuited.....	Poor: slope.....	Slope.....	Medium susceptibility to piping; very stony; medium to low shear strength; medium compressibility; fair compactibility.	Not needed.....	Steep slope; stony.
Poor: susceptible to frost action.	Unsuited.....	Fair: silty clay loam.	Unstable banks.	Medium to low shear strength; fair compactibility; medium compressibility; low susceptibility to piping.	Not needed.....	Erosion hazard if slope is more than 2 percent.
Good.....	Unsuited.....	Poor: gravelly.	Rapid permeability.	Good compactibility; medium susceptibility to piping.	Not needed.....	Moderate available water capacity; gravelly.
Fair: susceptible to frost action.	Unsuited.....	Fair: gypsum..	Moderate permeability; gypsum.	Medium susceptibility to piping; medium to low shear strength; fair compactibility; medium compressibility.	Not needed.....	Erosion hazard if slope is more than 2 percent.
Good if slope is less than 15 percent, fair if 15 to 25.	Unsuited.....	Poor: gravel and cobbles.	Rapid permeability.	Very cobbly; good to fair compactibility; high to medium shear strength.	Not needed.....	Low available water capacity; gravel and cobbles; rapid permeability.

TABLE 5.—Engineering

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfill ¹	Local roads and streets
*Sanpitch: SDE, SEE----- For Obrast part of SEE, see Obrast series.	Moderate if slope is less than 15 percent; stony; moderate permeability. Severe if slope is more than 15 percent; stones.	Severe: slope; stony.	Moderate if slope is 8 to 15 percent; stony. Severe if slope is more than 15 percent.	Moderate if slope is 8 to 15 percent; stony. Severe if slope is more than 15 percent.	Moderate if slope is less than 25 percent, severe if more than 25.	Moderate: medium susceptibility to frost action; slope. Severe: slope; more than 15 percent.
Sanpitch variant: SFD-----	Moderate if slope is less than 15 percent; stony; moderate permeability. Severe if slope is more than 15 percent.	Severe: slope; stones.	Moderate if slope is 8 to 15 percent; stony. Severe if slope is more than 15 percent.	Moderate if slope is 8 to 15 percent; stony. Severe if slope is more than 15 percent.	Moderate if slope is less than 25 percent, severe if more than 25.	Moderate: medium susceptibility to frost action; slope. Severe if slope is more than 15 percent.
Sedwell----- Mapped only with Lizzant soil.	Severe: moderately slow permeability; shallow over bedrock.	Severe: slope; shallow over bedrock.	Moderate if slope is less than 15 percent; shallow over bedrock. Severe if slope is more than 15 percent.	Moderate: moderate shrink-swell potential. Severe if slope is more than 15 percent.	Severe: texture; difficult to work; shallow over bedrock.	Severe: highly susceptible to frost action; slope.
Shaly colluvial land: SH. No interpretations were made. Material too variable.						
Shumway: Sm, Sn-----	Severe: water table at depth of 10 to 60 inches; slow permeability.	Severe: water table at depth of 10 to 60 inches.	Severe: water table at depth of 10 to 60 inches.	Severe: water table at depth of 10 to 60 inches; high shrink-swell potential.	Severe: water table at depth of 10 to 60 inches; texture.	Severe: water table at depth of 10 to 60 inches; susceptible to frost action.
Sigurd: SoD2, SpC-----	Slight ⁵ -----	Severe: rapid permeability.	Severe: very gravelly.	Slight-----	Severe: rapid permeability.	Slight to moderate: slope.
Skumpah: SrB, SrC2-----	Severe: moderately slow permeability.	Severe: gypsum, unstable.	Slight-----	Severe: gypsum, uneven settlement.	Moderate: texture.	Severe: highly susceptible to frost action.
Skylick: SSD, SSF-----	Severe: slow permeability; slope.	Moderate if slope is less than 7 percent, severe if more than 7.	Moderate if slope is less than 15 percent, severe if more than 15.	Moderate: moderate shrink-swell potential. Severe if slope is more than 15 percent.	Moderate: texture.	Severe: highly susceptible to frost action; slope.
Snake Hollow: StB-----	Slight ⁵ -----	Severe: moderately rapid permeability.	Moderate: gravelly.	Slight-----	Severe: moderately rapid permeability.	Moderate: moderately susceptible to frost action.
Tingey: TGG, TGH-----	Severe: slope; moderately slow permeability.	Severe: slope.	Severe: slope; stones.	Severe: slope; stones.	Severe: slope; stones.	Severe: slope; highly susceptible to frost action.

See footnotes at end of table.

interpretations—Continued

Suitability as source of—			Soil features affecting—			
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Dikes, levees, and other embankments	Drainage for crops and pasture	Irrigation
Fair: susceptible to frost action; slope. Poor: slope more than 25 percent.	Unsuited.....	Poor: stones; gravel; cobbles.	Slope; moderate permeability.	Low susceptibility to piping; medium shear strength; low compressibility.	Not needed.....	Steep slope; stony.
Fair: susceptible to frost action; slope. Poor if slope is more than 15 percent.	Unsuited.....	Poor: gravel; cobbles; stones.	Moderate permeability.	Low susceptibility to piping; medium to low shear strength; fair compactibility; medium compressibility.	Not needed.....	Steep slope.
Poor: susceptible to frost action.	Unsuited.....	Fair: silty clay loam.	Slope; moderately slow permeability.	Medium to low shear strength; fair to good compactibility; medium compressibility.	Not needed.....	Steep slope.
Poor: water table at depth of 10 to 60 inches; high shrink-swell potential; susceptible to frost action.	Unsuited.....	Poor: silty clay.	Water table at depth of 10 to 60 inches.	High water table; medium to low shear strength; fair to good compactibility; medium compressibility.	Not feasible: seasonally flooded in places.	Water table at depth of 10 to 60 inches; slow permeability.
Good.....	Poor: fines; GM material.	Poor: gravel....	Rapid permeability.	Good compactibility.	Not needed.....	Low available water capacity; cobbly.
Poor: highly susceptible to frost action.	Unsuited.....	Poor: saline-alkali; gypsum salts.	Saline-alkali; gypsum salts.	Not suitable; gypsum; saline-alkali; high susceptibility to piping.	Not needed.....	Saline-alkali; gypsum salts; moderately slow permeability.
Poor: highly susceptible to frost action.	Unsuited.....	Good to a depth of 24 inches; poor below and poor if slope is more than 15 percent.	Slope.....	Medium to low shear strength; fair compactibility; medium compressibility; moderate susceptibility to piping.	Not needed.....	Steep slope.
Fair: moderately susceptible to frost action.	Poor: too many fines; GC, SC, SM, or GM material.	Poor: gravel....	Moderately rapid permeability.	Medium shear strength; low compressibility; good compactibility.	Not needed.....	Moderate available water capacity.
Poor: slope; stones; highly susceptible to frost action.	Unsuited.....	Poor: stones; slope.	Slope.....	Medium shear strength; fair to good compactibility; low to medium compressibility; stones.	Not needed.....	Very steep slope.

TABLE 5.—Engineering

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfill ¹	Local roads and streets
Toehead: ToB, ToC.....	Severe: moderately slow permeability.	Moderate if slope is less than 7 percent, severe if more than 7.	Slight.....	Moderate: moderate shrink-swell potential.	Moderate: silty clay loam.	Severe: highly susceptible to frost action.
Toehead variant: TSD...	Moderate if slope is less than 15 percent; moderate permeability. Severe if slope is more than 15 percent.	Moderate if slope is less than 7 percent, severe if more than 7.	Slight.....	Moderate: moderate shrink-swell potential.	Slight.....	Severe: highly susceptible to frost action.
Torrifluvents and Torriorthents: TT. No interpretations. Material too variable.						
Toze: TVD.....	Moderate if slope is 8 to 15 percent; moderate permeability. Severe if slope is more than 15 percent.	Moderate if slope is less than 7 percent; moderate permeability. Severe if slope is more than 7 percent.	Moderate if slope is less than 15 percent, severe if more than 15.	Slight if slope is less than 8 percent, moderate if 8 to 15, severe if more than 15.	Moderate if slope is 15 to 25 percent.	Moderate if slope is less than 15 percent, severe if more than 15.
Wales: WAC.....	Moderate: moderate permeability.	Moderate: slope; moderate permeability.	Slight.....	Slight.....	Slight.....	Moderate: moderately susceptible to frost action.
WcA, WcB.....	Slight.....	Moderate: moderate permeability; slope.	Severe: very gravelly below a depth of 30 inches.	Slight.....	Severe: moderate permeability.	Moderate: moderately susceptible to frost action.
Wallsburg: WDE, WEG..	Severe: shallow over bed-rock; slope.	Severe: shallow over bed-rock; slope.	Severe: shallow over bed-rock; slope.	Severe: shallow over bed-rock; slope.	Severe: shallow over bed-rock; slope.	Severe: shallow over bed-rock.
Watkins Ridge: WGD, WhB.	Moderate: moderate permeability. Severe for WGF: more than 15 percent slope.	Moderate: moderate permeability; slope. Severe for WGD: slope.	Slight if slope is less than 8 percent, moderate if 8 to 15, severe if more than 15.	Slight if slope is less than 8 percent, moderate if 8 to 15, severe if more than 15.	Slight if slope is less than 15 percent, moderate if more than 15.	Moderate: moderately susceptible to frost action. Severe for WGD: slope.

See footnotes at end of table.

interpretations—Continued

Suitability as source of—			Soil features affecting—			
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Dikes, levees, and other embankments	Drainage for crops and pasture	Irrigation
Poor: highly susceptible to frost action.	Unsuited.....	Fair: silty clay loam.	-----	Medium to low shear strength; fair to good compactibility; medium compressibility.	Not needed.....	Erosion hazard if slope is more than 4 percent.
Poor: highly susceptible to frost action.	Unsuited.....	Good.....	-----	Moderately susceptible to piping; medium to low shear strength; fair to good compactibility; medium compressibility.	Not needed.....	Moderate permeability.
Fair: susceptible to frost action.	Unsuited.....	Fair if slope is 8 to 15 percent; gravel. Poor if slope is more than 15 percent.	Slope; moderate permeability.	Medium to high shear strength; fair to good compactibility.	Not needed.....	Steep slope.
Fair: moderately susceptible to frost action.	Unsuited.....	Good to a depth of 8 to 16 inches; fair below: silty clay loam.	Moderate permeability.	Moderate susceptibility to piping; medium to low shear strength; fair to good compactibility; medium compressibility.	Not needed.....	Erosion hazard if slope is more than 3 percent.
Fair: moderately susceptible to frost action.	Unsuited.....	Fair to a depth of 8 to 16 inches; silty clay loam; poor below: gravelly.	Moderately rapid permeability below a depth of 30 inches.	Above a depth of 40 inches: medium to low shear strength; fair compactibility; medium compressibility. Below a depth of 40 inches: fair to good compactibility.	Not needed.....	Low available water capacity below a depth of 30 inches; erosion hazard if slope is more than 3 percent.
Poor: shallow over bedrock; susceptible to frost action.	Unsuited.....	Poor: stony; shallow over bedrock.	Shallow over bedrock.	Very stony; shallow over bedrock; medium shear strength; low compressibility.	Not needed.....	Steep slope; shallow over bedrock.
Fair: moderately susceptible to frost action.	Unsuited.....	Good to a depth of 8 to 16 inches; fair below; poor if slope is more than 15 percent.	Moderate permeability; slope.	Medium to low shear strength; fair compactibility; medium compressibility; medium susceptibility to piping.	Not needed.....	Erosion hazard if slope is more than 3 percent; steep slope on WGD.

TABLE 5.—Engineering

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfill ¹	Local roads and streets
Woodrow: WoA, WoC2..	Severe: moderately slow permeability.	Slight if slope is less than 2 percent, moderate if 2 to 7.	Slight.....	Moderate: moderate shrink-swell potential.	Moderate: silty clay loam.	Severe: highly susceptible to frost action.
Xerofluvents and Fluvaquents: XE. No interpretations. Material too variable.						
Xerofluvents and Fluvaquents: XF. No interpretations. Material too variable.						
Yeates Hollow: YHE.....	Severe: slow permeability; slope.	Severe: slope..	Severe: slope..	Severe: slope..	Moderate if slope is 15 to 25 percent; silty clay loam. Severe if slope is more than 25 percent.	Severe: slope; highly susceptible to frost action.
*Zeesix: ZSE, ZTE..... For Toze part of ZTE, see Toze series.	Moderate if slope is 8 to 15 percent; moderate permeability. Severe if slope is more than 15 percent.	Severe: slope..	Severe if slope is more than 15 percent; very cobbly. Moderate if slope is 8 to 15 percent; gravelly.	Moderate if slope is 8 to 15 percent, severe if more than 15.	Severe: cobbly clay; slope.	Severe: slope; highly susceptible to frost action.

¹ If landfill is more than 5 or 6 feet deep, onsite study of the underlying strata and water table is needed to determine the hazards of aquifer pollution and drainage into ground water.

² Soil is 10 to 20 inches deep over hard bedrock.

³ Soil is 10 to 20 inches deep over shale.

to persons who use this survey. Many of the terms used in describing the soils and their use and management are defined in the Glossary near the back of the survey.

Engineering test data

Samples from some representative soil types in Sanpete County, Utah, were tested by the Cooperative Soils Laboratory, Logan, Utah, to assist in evaluation for engineering purposes. These test data are given in table 6. The test data show the characteristics of the soil at a specified location.

The engineering classifications given in table 6 are based on field evaluation supported by laboratory tests on selected soils. Laboratory tests consisted of mechanical analysis by sieving and by hydrometer, and also determining liquid limit and plastic limit (Atterburg limits).

The tests to determine plastic limit and liquid

limit measure the effect of water on the consistence of the soil material. As the moisture content of a clayey soil increases from a very dry state, the material changes from a semisolid state to a plastic state. As the moisture content is increased, the material changes from a plastic state to a liquid state. The plastic limit is the moisture content at which the soil material passes from a semisolid state to a plastic state. The liquid limit is the moisture content at which the material passes from a plastic state to a liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit, and indicates the range of moisture content within which the soil material is in a plastic condition.

Recreation

This section describes the limitations of the soils for recreational uses. The soil limitation ratings are based

interpretations—Continued

Suitability as source of—			Soil features affecting—			
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Dikes, levees, and other embankments	Drainage for crops and pasture	Irrigation
Poor: highly susceptible to frost action.	Unsuited.....	Fair: silty clay loam.	-----	Low susceptibility to piping; medium to low shear strength; fair compactibility; medium compressibility.	Not needed.....	Erosion hazard if slope is more than 2 percent.
Poor: slope; highly susceptible to frost action.	Unsuited.....	Poor: stony; slope.	Slope.....	Medium shear strength; poor to fair compactibility; low to medium compressibility; difficult to work; very stony.	Not needed.....	Steep slope; stony.
Poor: highly susceptible to frost action.	Unsuited.....	Poor: stony; slope.	Slope; moderate permeability.	Very stony; difficult to work; medium shear strength; low compressibility.	Not needed.....	Steep slope.

⁴ Soil is 10 to 20 inches deep over an indurated hardpan.

⁵ Pollution is a hazard in places because of rapidly permeable substratum.

⁶ Good for road fill except for slope.

mainly on the anticipated difficulties of preparing a site for its intended use and maintaining the facilities.

Table 7 does not include soil interpretations for cottages or summer homes, which are covered under "Dwellings without basements" in table 5.

The soil limitations for camp areas and picnic areas are similar and are rated together. The ratings apply to the use of soils for tents, small camp trailers, and picnic tables. It is assumed that vehicular traffic will be confined to access roads, and that little site preparation will be done other than shaping or leveling.

Playground ratings assume that the soils will be used intensively for baseball, football, badminton, volleyball, or other organized games of intensive foot traffic. The most desirable soils are free of stones, cobblestones, or gravel.

Path and trail ratings are for local and cross-country footpaths or bridle paths on which little or no soil will be moved.

Soil characteristics most likely to affect the intended recreational use were considered in making the ratings. Permeability of the subsoil, for example, is not applicable to ratings for campgrounds or picnic areas, because they are used primarily during the dry season. Texture of the surface layer is evaluated only in terms of limitations, dustiness when the soil is dry and slickness and muddiness when the soil is wet. The number of cobblestones or stones on the surface is important for playgrounds, where a smooth, firm surface is needed.

Slope is an important factor in rating the soils, but limitations for the same slope may vary with the intended use. For example, slope is a severe or very severe limitation to all recreational uses if it exceeds 25 percent, and it is a severe limitation for all uses except paths and trails if it is between 15 and 24 percent. A dominant slope of more than 6 percent is a severe limitation for playgrounds. Similarly, a

TABLE 6.—Engineering

[Test performed by the Cooperative Soils Laboratory at Logan in accordance with standard

Soil name and location	Parent material	Report number	Depth	Moisture density ¹		Percentage of material less than 3 inches in diameter passing sieve ²		
				Maximum dry density	Optimum moisture	1 inch	3/4 inch	3/8 inch
			<i>In</i>	<i>Lb per cu ft</i>	<i>Pct</i>			
Arapien fine sandy loam: 330 feet west and 100 feet south of the center of sec. 21, T. 20 S., R. 1 E. (Modal)	Alluvium derived from limestone, sandstone, and shale.	U67632	0-13	111	15	-----	-----	100
		U67633	13-30	93	26	-----	-----	100
		U67634	30-48	120	14	-----	-----	-----
Calita loam: 1,580 feet south and 477 feet east of the northwest corner of sec. 19, T. 14 S., R. 3 E. (Modal)	Alluvium derived from limestone, sandstone, and shale.	691829	0-12	108	17	-----	-----	100
		691830	12-20	106	21	-----	-----	-----
		691831	30-60	115	16	-----	-----	-----
Collard gravelly sandy loam: 2,700 feet west and 480 feet north of the southeast corner of sec. 36, T. 14 S., R. 2 E. (Modal)	Alluvium derived from sandstone and quartzite.	691835	0-6	117	12	93	90	84
		691836	6-20	122	11	76	73	66
		691837	20-60	114	11	50	43	36
Doyce loam: 1,650 feet north and 250 feet east of the southwest corner of sec. 8, T. 16 S., R. 4 E. (Modal)	Alluvium derived mainly from sandstone.	691838	0-10	115	16	-----	-----	-----
		691839	10-20	109	17	-----	-----	-----
		691840	20-44	110	17	95	93	90
Dyrenge silty clay: 26,640 feet north and 1,485 feet west of the southeast corner of sec. 25, T. 19 S., R. 1 W. (Modal)	Alluvium derived mainly from shale.	U67622	0-10	102	21	-----	-----	-----
		U67623	10-60	104	21	-----	-----	-----
Linoyer very fine sandy loam: NE 1/4 SW 1/4 sec. 26, T. 19 S., R. 1 W. (Not modal profile but representative of series)	Alluvium derived from sandstone and limestone.	U67624	0-11	111	18	-----	-----	-----
		U67625	11-60	114	16	-----	-----	-----
Moroni silty clay: 1,980 feet east and 165 feet south of the northwest corner of sec. 21, T. 14 S., R. 4 E. (Modal)	Alluvium derived from shale, mixed igneous rock, and quartzite.	691824	0-9	87	32	-----	-----	-----
		691825	9-41	83	35	-----	-----	-----
Mountainville very stony sandy loam: 1,600 feet south and 2,800 feet east of the northwest corner of sec. 31, T. 14 S., R. 4 E. (Modal)	Alluvium derived from sandstone, limestone, and quartzite.	691842	0-20	118	12	94	92	89
		691843	20-38	121	12	90	89	88
		691844	38-60	117	14	92	90	83
Obrast silty clay: 1,320 feet west and 660 feet north of the southeast corner of sec. 30, T. 9 S., R. 4 E. (Modal)	Alluvium derived from shale, limestone, and basic igneous rocks.	691841	0-60	88	13	-----	-----	100
Toehead silt loam: 1,815 feet east and 330 feet north of the southwest corner of sec. 13, T. 13 S., R. 4 E. (Modal)	Alluvium derived from limestone, sandstone, and shale.	691826	0-22	105	20	-----	-----	-----
		691827	22-41	105	22	-----	-----	-----
		691828	41-58	101	23	-----	-----	-----
Woodrow silty clay loam: 2,800 feet south and 625 feet east of the northwest corner of sec. 23, T. 19 S., R. 1 W. (Modal)	Alluvium derived from limestone, sandstone, and shale.	U67635	0-18	104	22	-----	-----	-----
		U67636	18-60	105	21	-----	-----	-----
Yeates Hollow stony silt loam: 1,650 feet west and 1,815 feet south of the northeast corner of sec. 27, T. 12 S., R. 3 E. (Modal)	Alluvium derived from igneous rock and quartzite.	691832	0-10	100	22	90	86	83
		691833	10-20	-----	-----	99	98	94
		691834	20-45	99	19	73	67	57

¹ Based on AASHTO Designation T99-57, Method A (1).² Mechanical analysis according to AASHTO Designation T88-57 (1). Results by this procedure differ somewhat from results obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHTO procedure, the fine material is analyzed by the hydrometer method, and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in

test data

procedures of the American Association of State Highway and Transportation Officials (AASHTO)]

Percentage of material less than 3 inches in diameter passing sieve ² —Continued				Percentage smaller than—			Liquid limit	Plasticity index	Classification	
No. 4	No. 10	No. 40	No. 200	0.05 mm	0.005 mm	0.002 mm			AASHTO	Unified
							<i>Pct</i>			
99	98	91	60	42	12	9	23	³ NP	A-4(3)	ML
99	97	90	60	43	21	15	35	9	A-4(3)	ML
100	98	93	56	44	26	20	29	12	A-6(4)	CL
99	97	90	53	49	29	20	25	5	A-4(0)	CL-ML
100	99	95	69	67	46	32	31	9	A-4(5)	CL
100	98	93	56	53	26	18	25	7	A-4(1)	CL-ML
79	75	63	30	27	11	8	NP	NP	A-2-4(0)	SM
61	57	47	23	20	10	8	NP	NP	A-1-b(0)	GM
31	27	18	3	2	2	2	NP	NP	A-1-a(0)	GW
100	99	97	54	48	24	17	20	NP	A-4(0)	ML
100	99	96	58	51	29	22	24	7	A-4(1)	CL-ML
77	74	70	42	37	19	14	22	5	A-4(0)	SC-SM
-----	100	99	97	97	62	38	41	18	A-7-6(19)	CL
-----	-----	100	99	98	81	57	39	17	A-6(18)	CL
100	99	98	85	76	28	17	25	5	A-4(2)	CL-ML
100	100	100	89	77	20	13	22	1	A-4(0)	ML
100	100	99	92	87	57	43	58	19	A-7-5(24)	MH
100	100	100	91	88	59	43	62	22	A-7-5(26)	MH
85	80	72	31	28	15	11	-----	NP	A-2-4(0)	SM
87	83	74	31	28	17	14	-----	NP	A-2-4(0)	SM
83	76	63	28	26	13	10	-----	NP	A-2-4(0)	SM
99	98	97	87	84	60	53	68	40	A-7-6(28)	CH
100	99	97	53	73	37	28	32	11	A-6(2)	CL
100	100	99	69	75	43	32	34	13	A-6(8)	CL
100	100	98	56	81	47	32	35	12	A-6(4)	CL
-----	-----	100	99	98	60	36	38	17	A-6(18)	CL
-----	-----	100	100	99	74	48	39	15	A-6(17)	CL
79	75	63	37	36	21	17	38	11	A-6(0)	SM
93	88	80	68	66	57	53	79	44	A-7-5(33)	CH
47	41	34	21	20	15	14	51	25	A-2-7(1)	GC

diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method, and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analysis data used in this table are not suitable for naming textural classes for soils.

³ NP = Nonplastic.

TABLE 7.—*Soil limitations for recreational uses*

Soil series and map symbols	Camp and picnic areas	Playgrounds	Paths and trails
Abcal: Aa, Ab	Severe: high water table	Severe: high water table	Severe: high water table.
Abcal-Cache: Ac	Severe: high water table	Severe: high water table	Severe: high water table.
Adel: ADG	Severe: slope	Severe: slope	Severe: slope.
Arntoft:			
AEE	Moderate if slope is less than 15 percent, severe if more than 15 percent.	Severe: slope; coarse fragments.	Moderate: slope; coarse fragments.
AFG2	Severe: slope; coarse fragments	Severe: slope; coarse fragments	Severe: slope; coarse fragments.
Anco: Ag	Moderate: dust problem	Moderate: dust problem	Moderate: dust problem.
Ant Flat:			
AHD	Moderate if slope is less than 15 percent, severe if more than 15 percent: permeability.	Severe: slope	Slight is slope is less than 15 percent, moderate if 15 to 25 percent.
AHE2	Severe: slope	Severe: slope	Severe: slope.
AkC	Moderate: permeability	Moderate: slope less than 6 percent.	Slight.
Ant Flat-Borvant: ALD.			
Ant Flat soil	Moderate: permeability	Moderate if slope is less than 6 percent, severe if more than 6 percent.	Slight.
Borvant soil	Moderate if slope is less than 15 percent, severe if more than 15 percent: coarse fragments.	Severe: slope	Moderate: slope; coarse fragments.
Arapien:			
AmB, AoB	Slight	Slight	Slight.
AmC2, ApC2	Slight	Moderate: slope	Slight.
AmD2	Slight is slope is less than 8 percent, moderate if 8 to 10 percent.	Severe: slope	Slight.
AnB	Severe: saline-alkali	Severe: saline-alkali	Slight.
Arapien-Calita: ARD.			
Arapien soil	Moderate: slope; coarse fragments	Severe: slope; coarse fragments	Moderate: slope; coarse fragments.
Calita soil	Slight	Moderate: slope	Slight.
Atepic:			
ASE2	Moderate if slope is less than 15 percent, severe if more than 15 percent: coarse fragments.	Severe: slope	Moderate if slope is less than 25 percent, severe if more than 25 percent: coarse fragments.
ATF	Severe: coarse fragments; slope	Severe: coarse fragments; slope	Severe: coarse fragments; slope.
Atepic variant: AUF	Severe: slope	Severe: slope	Severe: slope.
Atepic-Badland: AV.			
Atepic soil	Moderate if slope is less than 15 percent, severe if more than 15 percent: coarse fragments.	Severe: slope	Moderate if slope is less than 25 percent, severe if more than 25 percent: coarse fragments.
Badland	Severe: slope	Severe: slope	Severe: slope.
Badland: BA	Severe: slope	Severe: slope	Severe: slope.
Bagard: BCE	Severe: stones; slope	Severe: stones; slope	Severe: stones; slope.
Bagard-Sanpitch: BDE	Severe: stones; slope	Severe: stones; slope	Severe: stones; slope.
Beek: Be	Moderate: surface texture; permeability; high water table.	Moderate: surface texture; permeability; high water table.	Moderate: surface texture; high water table.
Bezzant:			
BFD	Moderate if slope is less than 15 percent, severe if more than 15 percent: coarse fragments.	Severe: slope	Moderate: slope; coarse fragments.
BGE	Severe: slope	Severe: slope	Severe: slope.
Bezzant-Gappmayer: BH	Severe: slope	Severe: slope	Severe: slope.
Billings: Bm	Moderate: surface texture; permeability	Moderate: surface texture; permeability.	Moderate: surface texture.
Birdow:			
BnB, BnC	Slight	Moderate: slope	Slight.
BoB	Severe: dust problem	Severe: dust problem	Severe: dust problem.
Borvant: BRD2	Moderate if slope is less than 15 percent, severe if more than 15 percent: coarse fragments.	Severe: slope	Moderate: coarse fragments; slope.
Borvant-Bagard: BSE2.			
Borvant soil	Moderate if slope is less than 15 percent, severe if more than 15 percent: coarse fragments.	Severe: slope	Moderate: coarse fragments; slope.
Bagard soil	Severe: stones; slope	Severe: stones; slope	Severe: stones; slope.
Borvant-Doyce: BTC.			
Borvant soil	Severe: stones	Severe: stones	Severe: stones.
Doyce soil	Slight	Moderate: slope	Slight.

TABLE 7.—*Soil limitations for recreational uses—Continued*

Soil series and map symbols	Camp and picnic areas	Playgrounds	Paths and trails
Borvant-Lodar: BUD2. Borvant soil.....	Moderate if slope is less than 15 percent, severe if more than 15 percent: coarse fragments.	Severe: slope.....	Moderate: coarse fragments; slope.
Lodar soil.....	Severe: coarse fragments; slope.....	Severe: coarse fragments; slope.....	Severe: coarse fragments; slope.
Bradshaw: BVG.....	Severe: slope; stones.....	Severe: slope; stones.....	Severe: slope; stones.
Calita: CaB, CaC.....	Slight.....	Moderate: slope.....	Slight.
Canburn: Cb.....	Severe: high water table.....	Severe: high water table.....	Severe: high water table.
Centerfield: CcB, CcC2.....	Moderate: surface texture; dust problem.	Moderate: surface texture; dust problem.	Moderate: surface texture; dust problem.
Cheadle: CDG.....	Severe: slope; coarse fragments.....	Severe: slope; coarse fragments.....	Severe: slope; coarse fragments.
Chipman: Ch, Cm.....	Severe: high water table.....	Severe: high water table.....	Severe: high water table.
Clegg: CNC.....	Slight.....	Moderate: slope.....	Slight.
Collard: CoC.....	Slight: some gravel.....	Moderate: slope.....	Slight: some gravel.
CRD.....	Moderate if slope is less than 15 percent, severe if more than 15 percent: coarse fragments.	Severe: slope; coarse fragments.....	Moderate: coarse fragments.
Crestline: CsC.....	Slight.....	Moderate: slope.....	Slight.
Cryoborolls: CU.....	Moderate if slope is less than 15 percent, severe if more than 15 percent.	Severe: slope.....	Moderate if slope is less than 25 percent, severe if more than 25 percent.
Daybell: DAG.....	Severe: slope.....	Severe: slope.....	Severe: slope.
Daybell-Flygare: DBG.....	Severe: slope.....	Severe: slope.....	Severe: slope.
Deer Creek: DCD, DED.....	Moderate if slope is less than 15 percent, severe if more than 15 percent: stones.	Severe: slope.....	Moderate if slope is less than 25 percent, severe if more than 25 percent: stones.
DEE.....	Severe: slope; stones.....	Severe: slope; stones.....	Severe: slope; stones.
Deer Creek-Mower: DFF.....	Severe: slope.....	Severe: slope.....	Severe: slope.
Denmark: DgC.....	Slight: some gravel.....	Moderate: slope.....	Slight: some gravel.
Donnardo: DhD.....	Moderate: slope; coarse fragments.....	Severe: slope.....	Moderate: coarse fragments.
DKD, DLD.....	Severe: stones.....	Severe: slope; stones.....	Severe: stones.
Doyce: DoB, DrB.....	Slight.....	Moderate: slope.....	Slight.
DoC.....	Slight.....	Moderate if slope is less than 6 percent, severe if more than 6 percent.	Slight.
Dyreg: Ds, Dy.....	Severe: surface texture; muddy when wet.	Severe: surface texture; muddy when wet.	Severe: surface texture.
Ephraim: Ep.....	Moderate: surface texture; mud and dust problem.	Moderate: surface texture; mud and dust problem.	Moderate: surface texture; mud and dust problem.
Fluvaquents: FN.....	Severe: high water table.....	Severe: high water table.....	Severe: high water table.
Fontreen: FOD.....	Moderate if slope is less than 15 percent, severe if more than 15 percent: coarse fragments.	Severe: slope.....	Moderate: coarse fragments.
FRE2, FRG2.....	Severe: coarse fragments; slope.....	Severe: coarse fragments; slope.....	Severe: coarse fragments; slope.
Fontreen-Borvant: FSD2.....	Moderate if slope is less than 15 percent: coarse fragments.	Severe: slope.....	Moderate: coarse fragments.
Freedom-Amtoft: FTD. Freedom soil.....	Moderate: dust problem.....	Moderate: slope; dust problem.....	Moderate: dust problem.
Amtoft soil.....	Moderate if slope is less than 15 percent, severe if more than 15 percent: coarse fragments.	Severe: slope.....	Moderate if slope is less than 25 percent, severe if more than 25 percent: coarse fragments.
Genola: GeB.....	Slight.....	Slight.....	Slight.
GeC2.....	Slight.....	Moderate: slope.....	Slight.
GeD2.....	Slight if slope is less than 8 percent, moderate if more than 8 percent.	Severe: slope.....	Slight if slope is less than 8 percent, moderate if more than 8 percent.
GkB.....	Severe: saline-alkali.....	Severe: saline-alkali.....	Slight.
Gothic: GOF2.....	Severe: slope; stones.....	Severe: slope; stones.....	Severe: slope; stones.
Green River: Gr.....	Slight.....	Slight.....	Slight.
Gullied land: Gu.....	Severe: slope.....	Severe: slope.....	Severe: slope.
Harding: Ha.....	Severe: saline-alkali; dust problem.....	Severe: saline-alkali; dust problem.	Severe: saline-alkali; dust problem.

TABLE 7.—*Soil limitations for recreational uses—Continued*

Soil series and map symbols	Camp and picnic areas	Playgrounds	Paths and trails
Harkers: HED.....	Moderate if slope is less than 15 percent, severe if more than 15 percent.	Severe: slope.....	Moderate: slope.
HKE.....	Severe: slope; stones.....	Severe: slope; stones.....	Severe: slope; stones.
Keigley: KcB.....	Moderate: surface texture; dust and mud problem.	Moderate: surface texture; dust and mud problem.	Moderate: surface tex- ture; dust and mud problem.
Kitchell: KEG.....	Severe: slope.....	Severe: slope.....	Severe: slope.
Kitchell-Mower: KM.....	Severe: slope.....	Severe: slope.....	Severe: slope.
Kjar: Kp.....	Severe: high water table.....	Severe: high water table.....	Severe: high water table.
Linoyer: LdB.....	Moderate: dusty.....	Slight.....	Slight.
LdC2.....	Moderate: dusty.....	Moderate: slope.....	Slight.
Lisade: LeB.....	Moderate: dusty.....	Slight.....	Slight.
LeC2.....	Moderate: dusty.....	Moderate: slope.....	Slight.
Lisade-Sanpete: LFC2.....	Moderate: dusty.....	Moderate: slope.....	Slight.
Lizzant: LGE.....	Severe: slope; coarse fragments.....	Severe: slope; coarse fragments.....	Severe: slope; coarse fragments.
LHD.....	Moderate: slope; stones.....	Severe: slope; stones.....	Moderate: slope; stones.
LKG.....	Severe: slope; stones.....	Severe: slope; stones.....	Severe: slope; stones.
Lizzant-Clegg: LLE. Lizzant soil.....	Severe: slope; coarse fragments.....	Severe: slope; coarse fragments.....	Severe: slope; coarse frag- ments.
Clegg soil.....	Slight.....	Moderate: slope.....	Slight.
Lizzant-Kitchell: LOF. Lizzant soil.....	Severe: slope; stones.....	Severe: slope; stones.....	Severe: slope; stones.
Kitchell soil.....	Severe: slope.....	Severe: slope.....	Severe: slope.
Lizzant-Mower: LMF.....	Severe: slope.....	Severe: slope.....	Severe: slope.
Lizzant-Sedwell: LNE. Lizzant soil.....	Severe: coarse fragments; slope.....	Severe: coarse fragments; slope.....	Severe: coarse fragments; slope.
Sedwell soil.....	Moderate if slope is less than 15 percent, severe if more than 15 percent.	Severe: slope.....	Moderate: slope.
Lodar: LRE.....	Severe: coarse fragments; slope.....	Severe: coarse fragments; slope.....	Severe: coarse fragments.
Lodar-Fontreen: LSG.....	Severe: slope; coarse fragments.....	Severe: slope; coarse fragments.....	Severe: slope; coarse fragments.
Lodar-Rock outcrop: LTE, LTG.....	Severe: slope; coarse fragments.....	Severe: slope; coarse fragments.....	Severe: slope; coarse fragments.
Lundy: LUE.....	Moderate if slope is less than 15 percent, severe if more than 15 percent; coarse fragments.	Severe: slope.....	Moderate if slope is less than 25 percent, severe if more than 25 percent; coarse fragments.
Manassa-Mellor: MA.....	Severe: saline-alkali.....	Severe: saline-alkali.....	Severe: saline-alkali.
Manila: MbC.....	Slight if slope is less than 8 percent, mod- erate if more than 8 percent.	Moderate if slope is less than 6 percent, severe if more than 6 percent.	Slight.
Mayfield: McB.....	Slight.....	Moderate: slope.....	Slight.
McB2.....	Moderate: gullies.....	Moderate: slope.....	Moderate: gullies.
Mellor: Md, Me.....	Severe: saline-alkali.....	Severe: saline-alkali.....	Severe: saline-alkali.
Moroni: MfC.....	Severe: surface texture; mud problem.....	Severe: surface texture; mud problem.	Severe: surface texture; mud problem.
Moroni-Atepic: MGD. Moroni soil.....	Severe: surface texture; mud problem.....	Severe: surface texture; mud problem.	Severe: surface texture; mud problem.
Atepic soil.....	Moderate if slope is less than 15 percent, severe if more than 15 percent; coarse fragments.	Severe: slope.....	Moderate if slope is less than 25 percent, severe if more than 25 percent; coarse fragments.
Mortenson: MHG.....	Severe: slope.....	Severe: slope.....	Severe: slope.
Mortenson-Skylick: MKG.....	Severe: slope.....	Severe: slope.....	Severe: slope.
Mortenson variant: MLD.....	Moderate if slope is less than 15 percent, severe if more than 15 percent.	Severe: slope.....	Moderate if slope is less than 25 percent, severe if more than 25 percent.
Mountainville: MmC, MnC.....	Severe: coarse fragments; slope.....	Severe: coarse fragments; slope.....	Severe: coarse fragments; slope.
Mountainville-Doyce: MoC. Mountainville soil.....	Severe: coarse fragments.....	Severe: coarse fragments.....	Severe: coarse fragments.
Doyce soil.....	Slight.....	Moderate: slope.....	Slight.
Mountainville variant: MrD.....	Moderate if slope is less than 15 percent, severe if more than 15 percent; coarse fragments.	Severe: slope.....	Moderate: coarse frag- ments.

TABLE 7.—*Soil limitations for recreational uses—Continued*

Soil series and map symbols	Camp and picnic areas	Playgrounds	Paths and trails
Mower:			
MSD.....	Moderate if slope is less than 15 percent, severe if more than 15 percent.	Severe: slope.....	Moderate if slope is less than 25 percent, severe if more than 25 percent.
MTD.....	Moderate if slope is less than 15 percent, severe if more than 15 percent: stony.	Severe: slope.....	Moderate if slope is less than 25 percent, severe if more than 25 percent: stony.
MUF2.....	Severe: slope.....	Severe: slope.....	Severe: slope.
Mower-Lundy: MVE.			
Mower soil.....	Moderate if slope is less than 15 percent, severe if more than 15 percent.	Severe: slope.....	Moderate if slope is less than 25 percent, severe if more than 25 percent.
Lundy soil.....	Moderate if slope is less than 15 percent, severe if more than 15 percent: coarse fragments.	Severe: slope.....	Moderate if slope is less than 25 percent, severe if more than 25 percent: coarse fragments.
Obrast:			
ObC.....	Moderate: surface texture; mud problem.	Severe: slope.....	Moderate: surface texture; mud problem.
OCD, ODD.....	Severe: surface texture; mud problem; slope.	Severe: surface texture; mud problem; slope.	Severe: surface texture; mud problem.
Pavant: PaC.....	Slight.....	Moderate if slope is less than 6 percent, severe if more than 6 percent.	Slight.
Pavant-Doyce: PDC.....	Slight.....	Moderate if slope is less than 6 percent, severe if more than 6 percent.	Slight.
Peteetneet: Pe.....	Severe: high water table.....	Severe: high water table.....	Severe: high water table.
Poganeab: Pg, Ph.....	Severe: high water table.....	Severe: high water table.....	Severe: high water table.
Poganeab variant: Pk.....	Severe: high water table.....	Severe: high water table.....	Severe: high water table.
Pritchett:			
PRF.....	Severe: slope.....	Severe: slope.....	Severe: slope.
PTE.....	Severe: slope.....	Severe: slope.....	Moderate if slope is less than 25 percent, severe if more than 25 percent.
Quaker: QkB, QkC.....	Moderate: surface texture; dust and mud problem.	Moderate: surface texture; dust and mud problem.	Moderate: surface texture; dust and mud problem.
Quaker-Mellor: Qm.....	Severe: saline-alkali.....	Severe: saline-alkali.....	Severe: saline-alkali.
Rapho:			
RaC.....	Slight: some gravel.....	Moderate: slope.....	Slight: some gravel.
RaD.....	Slight if slope is less than 8 percent, moderate if more than 8 percent.	Moderate if slope is less than 6 percent, severe if more than 6 percent.	Slight.
Ravola:			
RIB.....	Slight.....	Slight.....	Slight.
RIC.....	Slight.....	Moderate: slope.....	Slight.
RIC2.....	Severe: gullies.....	Severe: gullies.....	Severe: gullies.
Rock land: RO.....	Severe: rocky; slope.....	Severe: rocky; slope.....	Severe: rocky; slope.
Sanpete:			
SaC.....	Moderate: gravelly.....	Moderate: gravelly; slope.....	Moderate: gravelly.
SbD2.....	Moderate: coarse fragments; slope.....	Moderate if slope is less than 6 percent, severe if more than 6 percent: coarse fragments.	Moderate: coarse fragments.
SCE2.....	Moderate if slope is less than 15 percent, severe if more than 15 percent: coarse fragments.	Severe: slope.....	Moderate if slope is less than 25 percent, severe if more than 25 percent: coarse fragments.
Sanpitch: SDE.....	Severe: coarse fragments; slope.....	Severe: coarse fragments; slope.....	Severe: coarse fragments.
Sanpitch-Obrast: SEE.			
Sanpitch soil.....	Severe: coarse fragments; slope.....	Severe: coarse fragments; slope.....	Severe: coarse fragments.
Obrast soil.....	Moderate: surface texture; mud problem.	Severe: slope.....	Moderate: surface texture; mud problem.
Sanpitch variant: SFD.....	Moderate if slope is less than 15 percent, severe if more than 15 percent.	Severe: slope.....	Moderate if slope is less than 25 percent, severe if more than 25 percent.
Shaly colluvial land: SH.....	Severe: coarse fragments; slope.....	Severe: coarse fragments; slope.....	Severe: coarse fragments; slope.
Shumway:			
Sm.....	Severe: high water table.....	Severe: high water table.....	Severe: high water table.
Sn.....	Moderate: soil texture; mud and dust problem.	Moderate: soil texture; mud and dust problem.	Moderate: soil texture; mud and dust problem.

TABLE 7.—*Soil limitations for recreational uses—Continued*

Soil series and map symbols	Camp and picnic areas	Playgrounds	Paths and trails
Sigurd:			
SoD2.....	Moderate: coarse fragments; slope.....	Severe: coarse fragments; slope.....	Severe: coarse fragments.
SpC.....	Moderate: gravelly.....	Severe: gravelly.....	Moderate: gravelly.
Skumpah:			
SrB.....	Severe: saline-alkali.....	Severe: saline-alkali.....	Severe: saline-alkali.
SrC2.....	Severe: saline-alkali; gullies.....	Severe: saline-alkali; gullies.....	Severe: saline-alkali; gullies.
Skylick:			
SSD.....	Moderate if slope is less than 15 percent, severe if more than 15 percent.	Severe: slope.....	Moderate if slope is less than 25 percent, severe if more than 25 percent.
SSF.....	Severe: slope.....	Severe: slope.....	Severe: slope.
Snake Hollow: StB.....	Slight: some gravel.....	Moderate: slope.....	Slight: some gravel.
Tingey-Rock outcrop:			
TGG.....	Slight.....	Moderate: slope.....	Slight.
TGH.....	Slight.....	Moderate if slope is less than 6 percent, severe if more than 6 percent.	Slight.
Toehead:			
ToB.....	Slight.....	Moderate: slope.....	Slight.
ToC.....	Slight.....	Moderate if slope is less than 6 percent, severe if more than 6 percent.	Slight.
Toehead variant: TSD.....	Slight if slope is less than 8 percent, moderate if 8 to 15 percent, severe if more than 15 percent.	Moderate if slope is less than 6 percent, severe if more than 6 percent.	Slight if slope is less than 15 percent, moderate if more than 15 percent.
Torrifluvents and Torrior-thents, stony: TT.....	Severe: stones.....	Severe: stones.....	Severe: stones.
Toze: TVD.....	Moderate if slope is less than 15 percent, severe if more than 15 percent: coarse fragments.	Moderate if slope is less than 6 percent, severe if more than 6 percent: coarse fragments.	Moderate if slope is less than 25 percent, severe if more than 25 percent: coarse fragments.
Wales:			
WAC.....	Slight.....	Moderate if slope is less than 6 percent, severe if more than 6 percent.	Slight.
WcA, WcB.....	Moderate: surface texture; mud and dust problem.	Moderate: surface texture; mud and dust problem.	Moderate: surface texture; mud and dust problem.
Wallsburg: WDE.....	Severe: slope; stones.....	Severe: slope; stones.....	Severe: slope; stones.
Wallsburg-Rock outcrop: WEG.....	Severe: slope; stones.....	Severe: slope; stones.....	Severe: slope; stones.
Watkins Ridge:			
WGD.....	Moderate if slope is less than 15 percent, severe if more than 15 percent: stones.	Moderate if slope is less than 6 percent, severe if more than 6 percent: stones.	Moderate if slope is less than 25 percent: stones.
WhB.....	Slight.....	Moderate: slope.....	Slight.
Woodrow: WoA, WoC2.....	Moderate: surface texture; mud and dust problem.	Moderate: surface texture; mud and dust problem.	Moderate: surface texture; mud and dust problem.
Xerofluvents and Fluvaquents: XE.....	Moderate: surface texture; high water table.	Moderate: surface texture; high water table.	Moderate: surface texture; high water table.
Xerofluvents and Fluvaquents, saline: XF.....	Severe: saline-alkali; high water table.....	Severe: saline-alkali; high water table.....	Severe: saline-alkali; high water table.
Yeates Hollow: YHE.....	Severe: slope; stones.....	Severe: slope; stones.....	Severe: slope; stones.
Zeesix: ZSE.....	Moderate if slope is less than 15 percent, severe if more than 15 percent: coarse fragments.	Severe: slope.....	Moderate if slope is less than 25 percent, severe if more than 25 percent: coarse fragments.
Zeesix-Toze: ZTE.....	Moderate if slope is less than 15 percent, severe if more than 15 percent: coarse fragments.	Severe: slope.....	Moderate if slope is less than 25 percent, severe if more than 25 percent: coarse fragments.

less steep slope is a moderate or slight limitation. These differences in slope ratings indicate the amount of land shaping or leveling needed to prepare sites for specified recreational uses.

Ratings for recreational uses do not consider location, accessibility, land value, kind of vegetation, water

supply, and other practical or esthetic features of a given site. In some situations, soil limitations can be modified or removed and the soil used safely as intended. An evaluation of these features made at the site being considered, used along with ratings of the soils given in table 7, is needed before selecting a site for a specific use.

Formation and Classification of Soils

This section describes the factors of soil formation and classifies the soil series in the Sanpete Valley Area according to the current system of classification.

Formation of Soils

Soils are formed by environmental forces acting upon soil material deposited or accumulated by various geologic agencies. Characteristics of a soil depend upon the chemical and mineralogical composition of the parent material; the climate under which the parent material has existed since accumulation; the plant and animal life on and in soil, including man; the relief, landform, or lay of the land; and the length of time the parent material has been subjected to active weathering forces. The relative importance of each factor differs from place to place, but generally the interaction of all factors determine the kind of soil that forms in any given place.

Soil development is generally expressed in terms of kinds and distinctness of horizons and their arrangement in the profile. Soil formation and development characteristics reflected in soil horizons in this survey area are accumulation of organic matter in the surface layer, movement and accumulation of carbonates, cementation of carbonates, clay enrichment of the subsoil, absence of carbonates in the soils, and depth to bedrock.

Parent material

Parent material is weathered rock or unconsolidated material from which soils are derived. The hardness, grain size, and porosity of the parent material and its content of weatherable minerals influence soil formation. The five main sources of parent material in this survey area are the shale hills or Badlands west of Mayfield; the Valley Mountains west of Gunnison, the Gunnison Plateau north of Gunnison, and the western slope of the Manti Mountains on the eastern edge of the survey area, all of which have similar geologic materials; mixed alluvium from a variety of rocks; the Cedar Hills that extend north and east of Moroni and north to Thistle; and Loafer Mountain. The soils that formed in each of these sources reflect the influence of parent material.

The Badlands west of Mayfield are of Jurassic age. The parent rocks are mainly variegated gray to red shale that is salty and gypsiferous. The soils surrounding these Badlands are alluvial fans and alluvial plains and formed in weathered alluvium derived from shale. Soils are in the Billings, Ravola, Mayfield, and Skumpah series. They contain variable quantities of salt and gypsum. Close to the hills, where the sediments have been moved only a short distance, the soils contain 8 to 34 percent gypsum and the conductivity of the saturation extract ranges from 3 to 15 millimhos per centimeter. The Ravola and Billings soils, formed in transported alluvium, contain less than 5 percent gypsum and are nonsaline or slightly saline affected. All of these soils, except the Mayfield soils, formed in medium textured and moderately fine textured alluvium containing few gravel or shale fragments. These soils

have cation exchange capacity to clay ratios of 0.2 to 0.6. The clay mineralogy, determined by X-ray diffraction, is dominantly illite and chlorite clays. Calcium carbonate equivalent is typically 15 to 20 percent between depths of 10 and 40 inches, except in the Mayfield soils where it is 40 percent or more. Mayfield soils contain 20 to 35 percent shale fragments. The Skumpah soils are saline-alkali affected and have layers of gypsum accumulation below the B horizon.

The Valley Mountains, the Gunnison Plateau, and the western slope of the Manti Mountains are composed of limestone, shale, and some sandstone sedimentary rocks of Tertiary age. These rocks are rich in calcium and magnesium carbonates, which have a dominant influence on the soils. Many of the soils formed in material from this source contain more than 40 percent carbonates.

Amtoft, Atepic, Lodar, Lundy, Mower, and Sedwell soils formed in this parent material. Amtoft, Lodar, and Lundy soils are 10 to 20 inches deep over limestone bedrock. They contain 35 to 80 percent coarse fragments, which typically are well coated with carbonate in the C horizon. The Atepic, Mower, and Sedwell soils are moderately fine textured. Atepic soils are 10 to 20 inches deep over shale. Clay mineralogy of the Atepic and Mower soils shows a dominance of illite clays. The Sedwell soils formed in alluvium and colluvium derived from limestone on an old shale land surface. These soils are 40 to 60 inches deep over soft limestone or shale and have a thick, dark-colored surface layer. The dark surface layer changes abruptly at a depth of 40 to 60 inches to a nearly white horizon containing shale fragments, and it eventually grades to shale.

The Borvant, Fontreen, Kitchell, Lizzant, and Zeesix soils formed in local alluvium and colluvium derived mainly from limestone on mountainsides and alluvial fans. These soils contain 35 to 80 percent coarse fragments. The A1 horizon has a low bulk density, generally less than 1 gram per cubic centimeter, which seems to be the result of an increase in voids created by the leaching of carbonates from this horizon. Borvant soils have an indurated lime-cemented hardpan at a depth of 10 to 20 inches. Kitchell and Zeesix soils are at higher elevations than Borvant soils and receive more precipitation. The Zeesix soils have a clay-enriched B horizon in which the soil mass is noncalcareous, although it is 40 percent carbonates, mostly derived from fine limestone fragments. Kitchell soils have a thick, dark loam surface layer. The Fontreen soils have a fairly equal distribution of montmorillonite and illite clays.

During Pleistocene time many small melt-water mountain streams entered the valleys. Alluvial fans formed by these streams coalesce in many places to form alluvial plains. The outwash left by these streams has a wide range of texture. In many places it includes large amounts of smooth, well-rounded limestone fragments and, in some places sandstone coarse fragments. Close to the mountains the coarse fragments are dominantly stones. Lower on the fans, the coarse fragments are mainly cobbles and gravel. Centerfield, Sanpete, and Sigurd soils formed in this alluvium, as their 35 to 80 percent coarse-fragment content shows.

Arapien and Lisade soils formed in finer textured alluvium farther out on the fan plains, but like the coarser textured soils, contain more than 40 percent carbonates. Denmark soils also formed in this alluvium but have indurated, lime-cemented hardpans at depths of less than 20 inches.

During recent geologic time some sediments were deposited on alluvial fans, flood plains, and valley bottoms. This moderately fine textured to moderately coarse textured alluvium is relatively unweathered. Well-drained to somewhat poorly drained Quaker, Rapho, and Ephraim soils formed in these materials. The fine-textured Shumway soils and the medium-textured Kjar soils formed on the valley bottoms, where drainage is poor.

On the stream flood plains, broad alluvial fans, and alluvial plains in the lower parts of the valley the alluvium is derived from a variety of rocks—sandstone, limestone, and shale from the Valley Mountains, Gunnison Plateau, and the western slope of the Manti Mountains; basalt and rhyolite from the upper part of the Sevier River watershed; and the pyroclastics, tuffs, and ignimbrites from the Cedar Hills area. Soils formed in this moderately coarse textured to fine-textured alluvium are strongly calcareous but contain less than 40 percent carbonates. They are well-drained to somewhat excessively drained Genola, Linoyer, Birdow, Calita, Crestline, Donnardo, Doyce, Keigley, Mountainville, Pavant, Snake Hollow, Toehead, Watkins Ridge, Woodrow, and Wales soils.

The poorly drained and somewhat poorly drained Abcal, Anco, Beek, Canburn, Chipman, and Poganeab soils are on valley bottoms. These soils have cation exchange capacity to noncarbonate clay ratios of 0.5 to 1.0. Determinations of clay composition show a fairly equal distribution of montmorillonite, kaolinite, and illite clays. Where these sediments were deposited in shallow water, the Mellor, Harding, and Manassa soils formed. These soils occupy the valley bottom from Fayette north to the county line and formed in finely stratified sediments deposited in an estuary of ancient Lake Bonneville. They are saline-alkali affected. The Mellor and Harding soils also occupy a strip $\frac{1}{4}$ to $\frac{1}{2}$ mile wide along the western side of the Sanpete Valley.

At the higher elevations on the western slope of the Manti Mountains are sandstone and some limestone and shale. Soils formed in colluvium and residuum derived from these rocks are in the Gothic, Mortenson, Pritchett, Skylick, Tingey, and Toze series. All of these except the Toze soils have a clay-enriched B horizon that is high in silicate clay. Although these soils formed in parent material derived mainly from sandstone, feldspar and mica are present.

The Ant Flat, Deer Creek, and Manila soils formed in similar parent materials in the foothill area where there is less precipitation. These soils also have a clay-enriched B horizon, and the Ant Flat and Deer Creek soils have a layer of carbonate accumulation. Differences among these soils appear to be closely related to the amount of carbonates in the parent material.

The Cedar Hills north and east of Moroni and north toward Thistle are dominated by the Moroni geologic formation of about Miocene age (4). This formation consists of about 2,000 feet of stratified clastics. The lower

half consists of stream-deposited pyroclastics intermixed with normal fluvial sediments, and the upper half consists of tuffs and welded tuffs or ignimbrites. Coarse conglomerate is extensive in this formation. The rounded cobblestones and stones are mainly quartzite, andesite, dacite and rhyolite, which explains the presence of these coarse fragments on the surface in many places. The soils that formed in the colluvium and residuum derived from this formation have a cobbly or very cobbly clay-enriched B horizon. These soils are in the Bagard, Harkers, Wallsburg, and Yeates Hollow series. Differences among these soils are caused by their content of coarse fragments and the amount of precipitation received. The Wallsburg soils are 10 to 20 inches deep over bedrock.

The Moroni Formation lies unconformably on a base of sedimentary rocks. In places, the formation is thin and has been partly or completely eroded away. Its sediments, mixing with those of the underlying shales, result in an alluvium which weathers rapidly into fine-textured material that has large quantities of montmorillonite clay. Moroni and Obrast soils formed in this alluvium.

Where the Moroni Formation is thin and the underlying rocks are mainly stratified limestone and shale, the soil parent material is strongly calcareous. Soils formed in this material are in the Sanpitch and Borvant series.

Loafer Mountain geologic formations consist mainly of sandstone and small amounts of limestone of Permian age (3). Adel, Bezzant, Bradshaw, Cheadle, Daybell, Flygare, and Gappmayer soils formed in the colluvium and residuum derived from these rocks. Reaction is medium acid to neutral, except in the Cheadle and Bezzant soils, which have a weak carbonate accumulation. Texture in all but the Adel soils is very cobbly or very flaggy sandy clay loam to sandy loam. Cheadle soils are 10 to 20 inches deep over bedrock.

Climate

The main effect of climate on soil formation in this survey area has been the direct influence of precipitation and temperature on the weathering of the parent material, the leaching and accumulation of carbonates, the redistribution of clay, and the accumulation of organic matter in the surface layers. Climate also directly affects the kinds of plant and animal life and their contribution to soil development.

The climate of the survey area ranges from semi-arid to moist subhumid continental. Winters are cold, and summers are warm. The area has relatively low humidity, abundant sunshine except in winter and early in spring, relatively light precipitation at the lower elevations, and a wide annual range in temperature.

Precipitation in the survey area ranges from slightly less than 8 inches at the lower elevations to about 30 inches at the higher elevations. The Manti weather station shows a uniform distribution of precipitation during the period October through May, averaging a little more than an inch per month. June through September is slightly drier, with an average of about 0.8 of an inch per month. Most of the survey area has a similar distribution pattern, but some sections receive less precipitation and some receive more. The

Gunnison Valley and higher elevations receive most of the precipitation as snow.

The mean annual air temperature ranges from about 52° F at the lower elevations to about 39° at the higher elevations. The frost-free period is 130 days at the lower elevations but drops to about 60 days at the higher elevations.

The lower valley has a semi-arid climate. The average annual precipitation is 8 to 13 inches, the mean annual air temperature is 45° to 52°, and the frost-free period is 110 to 130 days. Elevation ranges from 5,000 to about 6,200 feet.

Soils in the lower part of the valley, except for the poorly drained soils, have a light-colored surface layer and a small amount of organic matter. The Genola, Linoyer, Quaker, Sigurd, and Rapho soils lack horizons other than slight accumulations of organic matter that make up the surface layer. The Arapien, Freedom, Lisade, and Sanpete soils have a light-colored surface layer and distinct horizons of carbonate accumulation. Mellor and Harding are saline-alkali affected soils, which have sodium-affected clay-enriched B horizons and distinct horizons of carbonate accumulation.

The foothill areas have a dry subhumid climate and an average annual precipitation of 10 to 20 inches. The mean annual air temperature is 42° to 52° F, and the frost-free period is 80 to 120 days. Elevation ranges from about 5,400 to 7,200 feet. Most of the foothill soils have accumulated enough organic matter in the upper 7 to 10 inches of the surface layer to give it a dark color; however, some soils, such as the Atepic and Wales soils, have a light-colored surface layer. The Birdow, Keigley, and Toehead soils have no soil horizons other than an accumulation of organic matter. Snake Hollow soils have a weak B horizon from which carbonates have been practically removed by leaching. Bezzant, Borvant, Calita, Donnardo, Fontreen, Lodar, Pavant, Sanpitch, and Watkins Ridge soils have a dark-colored surface layer and a distinct horizon of carbonate accumulation. The carbonate layer in the Borvant and Pavant soils is cemented so as to form an indurated hardpan. Doyce and Mountainville soils have a dark surface layer, a clay-enriched B horizon, and horizons of carbonate accumulation.

The moist-subhumid mountain areas have an average annual precipitation ranging from 14 to 30 inches, a mean annual air temperature of 36° to 45° F, and a mean summer air temperature of 58° to 62° F. The frost-free period is 80 to 100 days. Elevation ranges from 5,500 to 9,700 feet. The mountain soils have a dark surface layer that has accumulated 2 to 5 percent organic carbon. Lizzant, Mower, Lundy, Kitchell, and Toze soils are calcareous throughout. In the Deer Creek, Ant Flat, Clegg, Harkers, Manila, and Yeates Hollow soils, the A1 horizon has been leached of carbonate and a distinct clay-enriched B horizon has formed. Ant Flat, Deer Creek, and Clegg soils have, in addition, a distinct layer of carbonate accumulation below the clay-enriched B horizon. In the upper part of the moist-subhumid climatic zone, the soils at the higher elevations have been leached of all carbonates and some have an A2 horizon.

Plant and animal life

The main effects of plant and animal life on soil formation are the accumulation of organic matter and the translocation of plant nutrients from the lower layers to the upper layers. Animals, insects, bacteria, and other organisms add organic matter to the soil and stir and aerate it. Their activity, however, depends in large part upon the vegetation that provides their food. Bacteria and fungi play an important role in the development of soils by breaking down undecomposed organic matter and changing it to humus. Some bacteria take nitrogen from the air and change it into a form that can be used by plants. Some living organisms, such as earthworms, enhance porosity and structure and thus influence the rate of air and water movement through the soil.

The native vegetation on the low, wet areas of the valley bottoms is wiregrass, saltgrass, broadleaf grasses, sedges, and other water-loving plants. These plants contribute much vegetation, and the high water table retards the activity of micro-organisms; therefore, the organic-matter content of the soil is high.

The nonsaline-alkali soils in the semi-arid climatic zone have a sparse stand of big sagebrush, yellowbrush, cheatgrass, Indian ricegrass, and squirreltail. The grasses make up a very low percentage of the vegetation, and, therefore, only small amounts of organic matter are added to the soil. Arapien, Sigurd, Linoyer, and Sanpete soils generally have 0.8 to 1.5 percent organic matter in the surface layer. After a period of cultivation and irrigation, the organic matter in the Woodrow and Linoyer soils increases to 2.6 to 3.4 percent. This increase is the result of applications of barnyard manure and increases in the amount of plant residue returned to the soil through cultivation and irrigation.

The saline-alkali Mellor, Manassa, and Harding soils, formed mainly under greasewood and shadscale, are also low in organic matter. Greasewood and shadscale are common salt-tolerant shrubs that have fleshy leaves that influence the content of salt in the soils. The leaves of both plants contain salts that have been assimilated from the soils. As the dropped leaves decompose, the mineral residue is again incorporated into the soil. The more soluble salts are leached away, but the sodium salts react with the soil to increase the amount of exchangeable sodium. Where these salts have accumulated under greasewood, small areas called slickspots appear when the greasewood plants are removed or die. These slickspots are evident for many years after the greasewood plants have disappeared.

The vegetation of the dry-subhumid climatic zone is mainly juniper, pinon, big sagebrush, bitterbrush, phlox, bluebunch wheatgrass, squirreltail, Indian ricegrass, Sandberg bluegrass, snakeweed, and forbs. In the dense juniper-pinon stands there is very little understory growth, and the soils are generally low in organic-matter content. The areas that have little or no juniper and pinon have a vegetative cover of big sagebrush, cheatgrass, snakeweed, and other forbs. They also have varying amounts of bluebunch wheatgrass, Indian ricegrass, needleandthread, and bitterbrush. These areas were probably dominated by grasses before overgrazing depleted the vegetation. The Fon-

treem, Mountainville, Doyce, Birdow, and Calita soils that occupy these areas contain 1 to 6 percent organic matter.

At the higher elevations in the moist-subhumid climatic zone, the vegetation consists of more shrubs, such as Gambel oak, snowberry, serviceberry, and bitterbrush. Grasses are bluebunch wheatgrass, slender wheatgrass, Sandberg bluegrass, and bearded wheatgrass. Yields of plants are higher in this zone because of the increase in precipitation. As a result, the organic-matter content of the soils is higher. The Clegg, Deer Creek, Ant Flat, Harkers, and Manila soils that occupy these areas contain 3 to 9 percent organic matter.

The high mountain areas in the upper part of the moist-subhumid climatic zone support mainly aspen and conifer forests. The abundant moisture and cool temperatures of these areas promote a lush vegetative cover. The Skylick and Pritchett soils that formed under aspen have an organic-matter content of 7 to 15 percent in the surface layer. The Mortenson soil, under conifers, lacks an A1 horizon, but has a thick A2 horizon that contains 2 to 6 percent organic matter.

Relief

Relief, or landform, influences soil formation chiefly as it affects runoff, drainage, and microclimate. The microclimatic influences are associated mainly with exposure and elevation.

The Manti Mountains form the eastern edge of the survey area; the Valley Mountains, west of Gunnison Valley, are in the western part; and the Gunnison Plateau is at the center. The area drains from east to west on the east side and from west to east on the west side. Runoff and streams coming into the valleys from both sides have provided sediment for valley fill and formed alluvial fans, alluvial plains, and flood plains.

The dominant landforms in this survey area are valley bottoms, recent alluvial fans, and flood plains; older fans, alluvial plains, and foothills; and mountainsides and ridges.

Valley bottoms, recent alluvial fans, and flood plains. The two principal valleys are Gunnison Valley and Sanpete Valley. Most of the cultivated soils are in these valleys. Gunnison Valley has the lowest elevation, and Sanpete Valley drains into it. The soils in the lowest parts of the valleys and on the flood plains are nearly level to gently sloping and are somewhat poorly drained to very poorly drained. In Sanpete Valley water ponds in spring as a result of snowmelt and during periods of high precipitation.

These low-lying soils that have a high water table are mottled or gleyed as a result of lack of oxygen. Water-loving plants produce abundantly, and in places thick layers of peat and muck have accumulated. The organic Petetneet soil formed in such layers. The Kjar soils, associated with Petetneet soils, also have a peaty surface layer underlain by very strongly calcareous mineral soil that contains an abundance of fresh-water snail shells. The high organic-matter content, dark color of the surface layer, and mottled soil colors of Abcal, Canburn, Chipman, Poganeab, and Shumway soils reflect the poor drainage in these areas.

At slightly higher elevations the water table is below the surface at least part of the time. Mottling or gleying is usually at a depth below 20 inches, and the surface layers have not been appreciably darkened by extra amounts of organic matter. The somewhat poorly drained Anco, Beek, Dyreng and Ephraim soils and the moderately well drained Green River soils that occupy these areas reflect these conditions.

On the recent alluvial fans and alluvial plains, above the somewhat poorly and poorly drained soils, are the well-drained Birdow, Genola, Quaker, and Woodrow soils. These soils lack discernible soil horizons other than a slight accumulation of organic matter in the surface layer. They are gently sloping to strongly sloping.

Older alluvial fans, alluvial plains, and foothills. The soils on these landforms are gently sloping to steep. They are well drained to somewhat excessively drained, and many have 35 to 80 percent coarse fragments in their control sections. In the Gunnison Valley and southern part of Sanpete Valley, the surface layers are light colored. In the northern part of Sanpete Valley and in the upper foothills, the surface layers have been darkened by organic matter. Most of the soils have an accumulation of carbonates at a depth of about 10 to 20 inches. Important on older fans are the Arapien, Lisade, Calita, Donnardo, and Sanpete soils.

Mountainsides and ridges. The soils on the mountainsides and ridges are well drained or somewhat excessively drained. Slope is moderately steep to very steep. The influence of exposure is apparent in most of the soils. The soils on southern exposures have lighter surface colors or a thinner dark surface layer than the soils on northern exposures at about the same elevation. Most of the soils on the mountainsides and ridges have dark surface layers. They are partly or completely leached of carbonates and soluble salts.

Soil temperature and soil moisture are also influenced by exposure. Soil temperatures and percent moisture at a depth of 20 inches were determined at regular intervals for 3 years for a north-facing Mortenson soil and a south-facing Tingey soil. These soils were on opposite sides of a canyon and at about the same elevation.

The Tingey soil temperature was about 41° F from about April 1 to November 8, and about 47° between June 1 and November 8. Soil moisture, by weight, was 15 to 18 percent between January 1 and June 1. It dropped steadily to 7 percent by September 30, but was back up to between 15 and 18 percent by December 1.

The Mortenson soil temperature was above 41° F from about June 1 to November 1 and above 47° from July 8 to October 12. Soil moisture, by weight, was 8 to 12 percent between January 1 and April 30. It then started to rise and reached a peak of 13 to 17 percent by June. It dropped steadily to 5 to 7 percent by October 1, and by December 1 was again 8 to 12 percent.

The soils on the two sites are strongly contrasting. The soil on the northern exposure lacks an A1 horizon but has a thick A2 horizon and a strongly developed B2t horizon. The soil on the southern exposure has an A1 horizon about 9 inches thick, a moderate B2t

horizons used to make separations are those in which careous below the B2t horizon. Both soils formed in material derived from sandstone rocks.

Time

The degree of development and distinctness of soil horizons depends in part on the length of time the soil-forming factors have been operating. The survey area ranges from young soils that have little or no horizon differentiation or profile development to mature soils that have well-developed profile characteristics.

In this survey area, the soils with the least horizon differentiation are on the recent alluvial fans in the semi-arid climatic zone. Genola, Quaker, Woodrow, Rapho, and Linoyer soils, for example, have no horizons other than a surface layer of slight organic-matter accumulation. The Arapien, Freedom, Lisade, and Sanpete soils that formed in similar but older deposits in the same climatic zone have horizons of carbonate accumulation.

The Harding and Mellor soils formed in clayey lake sediments. Although these soils are more recent than the soils on the older landscapes, they have A2 and B2t horizons with strong prismatic structure. Because these sediments contain sodium, clay illuviation could proceed without prior movement of the lime, and formation of the B2t horizon has been rapid.

On some mountainsides, where soils formed in parent materials high in carbonates, there has not been time for all the carbonates to be leached from the A horizon. There has been some leaching, however, and horizons that have large accumulations of carbonates have formed. Important examples of these horizons are in the Fontreen, Lizzant, and Zeesix soils. In places where the landscapes have been stable and the soils have been in place longer, an indurated lime-cemented hardpan has formed. Borvant and Pavant soils are examples of soils that have a hardpan.

Ant Flat, Bagard, Deer Creek, Manila, and Harkers soils are mature. They have a dark-colored surface layer and a clay enriched B2t horizon, which is mainly leached of carbonates. Ant Flat and Deer Creek soils have distinct horizons of carbonate accumulation.

Obrast and Moroni soils have minimal profile development even though they are on old landscapes and have been in place for a long time. These clayey soils have cracks that open and close each year, disrupting the soil-forming processes. The effect of time on soil development in these soils is negligible, except for further darkening of the upper layers.

Most differences in profile development result from the combined effect of other soil-forming factors, rather than the effect of time.

Classification of Soils

Soils are classified so that their significant characteristics are more easily remembered. Classification enables one to assemble knowledge about the soils, to see their relationship to one another and to the whole environment, and to develop principles that help understand their behavior and their response to manipulation. First through classification, and then through use

of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

The narrow categories of classification, such as those used in detailed soil surveys, allow us to organize and apply knowledge about soils in managing cultivated fields, rangelands, and woodlands; in developing rural areas; in engineering work; and in many other ways. Soils are placed in broad classes to facilitate study and comparison in large areas such as countries and continents.

Two systems of classifying soils have been used in the United States in recent years. The older system was adopted in 1938 and later revised (6). The system currently used was adopted by the National Cooperative Soil Survey in 1965 (5,8). The current system of classification has six categories. Beginning with the broadest, these categories are order, suborder, great group, subgroup, family, and series. Criteria used as a basis for this classification are observable and measurable soil properties. The properties are chosen, however, so that the soils of similar genesis, or mode of origin, are grouped together.

In table 8, the soil series of Sanpete Valley Area are placed in four categories of the current system. Classes of the current system are briefly defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The properties used to differentiate among soil orders are those that tend to give broad climatic groupings of soils. The two exceptions to this are Entisols and Histosols, which are present in many different climates. Each order is named with a word of three or four syllables ending in *sol* (Ent-i-sol).

The seven soil orders represented in the Sanpete Valley Area are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Alfisols, and Histosols.

SUBORDER. Each order is subdivided into suborders that are based primarily on those soil characteristics that seem to produce classes with the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of waterlogging, or soil differences resulting from the climate or vegetation. The names of suborders have two syllables. The last syllable indicates the order. An example is Aquent (*Aqu*, meaning water or wet, and *ent*, for Entisol).

GREAT GROUP. Soil suborders are separated into great groups on the basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated; those that have a pan that interferes with growth of roots, movement of water, or both; and a thick, dark surface horizon. The features used include the self-mulching properties of clay, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), and dark-red and dark-brown colors associated with basic rocks. The names of great groups have three or four syllables and are made by adding a prefix to the name of the suborder. An example is Fluvaquent (*Fluv*, meaning fluvial, *aqu* for wetness or water, and *ent*, from Entisols).

TABLE 8.—*Classification of soils*

Series	Family	Subgroup	Order
Abcal.....	Fine, mixed (calcareous), mesic	Typic Fluvaquents	Entisols.
Adel.....	Fine-loamy, mixed	Pachic Cryoborolls	Mollisols.
Amtoft.....	Loamy-skeletal, carbonatic, mesic	Lithic Xerollic Calciorthids	Aridisols.
Anco.....	Fine-silty, mixed (calcareous), mesic	Aquic Xerofluvents	Entisols.
Ant Flat.....	Fine, montmorillonitic, frigid	Calcic Argixerolls	Mollisols.
Arapien.....	Fine-loamy, carbonatic mesic	Xerollic Calciorthids	Aridisols.
Atepic.....	Loamy, carbonatic, mesic, shallow	Xerollic Calciorthids	Aridisols.
Atepic variant.....	Clayey, mixed, mesic, shallow	Xerollic Haplargids	Aridisols.
Bagard.....	Clayey-skeletal, montmorillonitic, frigid	Aridic Argixerolls	Mollisols.
Beek.....	Fine-loamy, mixed, mesic	Pachic Calcicustolls	Mollisols.
Bezzant.....	Loamy-skeletal, mixed, frigid	Typic Calcixerolls	Mollisols.
Billings.....	Fine-silty, mixed (calcareous), mesic	Typic Torrifluvents	Entisols.
Birdow.....	Fine-loamy, mixed, mesic	Cumulic Haploxerolls	Mollisols.
Borvant.....	Loamy-skeletal, carbonatic	Aridic Petrocalcic Palexerolls	Mollisols.
Bradshaw.....	Loamy-skeletal, mixed, frigid	Typic Haploxerolls	Mollisols.
Cache.....	Fine, mixed, mesic	Typic Salorthids	Aridisols.
Calita.....	Fine-loamy, mixed, mesic	Aridic Calcixerolls	Mollisols.
Centerfield.....	Fine-loamy over sandy or sandy-skeletal, carbonatic, mesic	Xeric Torrifluvents	Entisols.
Cheadle.....	Loamy-skeletal, mixed	Lithic Cryoborolls	Mollisols.
Chipman.....	Fine-silty, mixed, mesic	Typic Calciaquolls	Mollisols.
Clegg.....	Fine-loamy, mixed, frigid	Calcic Pachic Argixerolls	Mollisols.
Collard.....	Loamy-skeletal, mixed, mesic	Aridic Argixerolls	Mollisols.
Crestline.....	Coarse-loamy, mixed, mesic	Xerollic Camborthids	Aridisols.
Daybell.....	Coarse-loamy over fragmental, mixed	Pachic Cryoborolls	Mollisols.
Deer Creek.....	Fine, montmorillonitic, frigid	Typic Palexerolls	Mollisols.
Denmark.....	Loamy, carbonatic, mesic, shallow	Xerollic Paleorthids	Aridisols.
Donnardo.....	Loamy-skeletal, mixed, mesic	Aridic Calcixerolls	Mollisols.
Doyce.....	Fine-loamy, mixed, mesic	Aridic Calcic Argixerolls	Mollisols.
Dyrenge.....	Fine, montmorillonitic (calcareous), mesic	Vertic Xerofluvents	Entisols.
Ephraim.....	Fine-silty, carbonatic, mesic	Aquic Xerofluvents	Entisols.
Flygare.....	Loamy-skeletal, mixed	Cryic Pachic Paleborolls	Mollisols.
Pontreen.....	Loamy-skeletal, carbonatic, frigid	Aridic Calcixerolls	Mollisols.
Freedom.....	Fine-silty, mixed, mesic	Xerollic Calciorthids	Aridisols.
Gappmayer.....	Loamy-skeletal, mixed, frigid	Boralfic Argixerolls	Mollisols.
Genola.....	Fine-silty, mixed (calcareous), mesic	Xeric Torrifluvents	Entisols.
Gothic.....	Fine, montmorillonitic	Argic Cryoborolls	Mollisols.
Green River.....	Coarse-loamy, mixed (calcareous), mesic	Aquic Ustifluvents	Entisols.
Harding.....	Fine, mixed, mesic	Xerollic Natrargids	Aridisols.
Harkers.....	Fine, montmorillonitic, frigid	Typic Palexerolls	Mollisols.
Keigley.....	Fine-silty, mixed, mesic	Cumulic Haploxerolls	Mollisols.
Kitchell.....	Loamy-skeletal, carbonatic	Calcic Pachic Cryoborolls	Mollisols.
Kjar.....	Fine-silty, carbonatic, mesic	Histic Humaquepts	Inceptisols.
Linoyer.....	Coarse-silty, mixed (calcareous), mesic	Xeric Torrifluvents	Entisols.
Lisade.....	Coarse-loamy, carbonatic, mesic	Xerollic Calciorthids	Aridisols.
Lizzant.....	Loamy-skeletal, carbonatic, frigid	Typic Calcixerolls	Mollisols.
Lodar.....	Loamy-skeletal, carbonatic, mesic	Lithic Calcixerolls	Mollisols.
Lundy.....	Loamy-skeletal, carbonatic, frigid	Lithic Calcixerolls	Mollisols.
Manassa.....	Fine-silty, mixed (calcareous), mesic	Xeric Torriorthents	Entisols.
Manila.....	Fine, montmorillonitic, frigid	Typic Argixerolls	Mollisols.
Mayfield.....	Fine-loamy, carbonatic, mesic	Xeric Torrifluvents	Entisols.
Mellor.....	Fine-silty, mixed, mesic	Xerollic Natrargids	Aridisols.
Moroni.....	Fine, montmorillonitic, mesic	Entic Chromoxererts	Vertisols.
Mortenson.....	Clayey-skeletal, montmorillonitic	Typic Paleboralfs	Alfisols.
Mortenson variant.....	Fine, montmorillonitic	Typic Cryoboralfs	Alfisols.
Mountainville.....	Loamy-skeletal, mixed, mesic	Aridic Calcic Argixerolls	Mollisols.
Mountainville variant.....	Clayey-skeletal, montmorillonitic, mesic	Aridic Petrocalcic Palexerolls	Mollisols.
Mower.....	Fine-loamy, carbonatic, frigid	Typic Calcixerolls	Mollisols.
Obrast.....	Fine, montmorillonitic, frigid	Vertic Haploxerolls	Mollisols.
Pavant.....	Loamy, mixed, mesic, shallow	Aridic Petrocalcic Palexerolls	Mollisols.
Peteetneet.....	Euic, mesic	Typic Medisaprists	Histosols.
Poganeab.....	Fine-loamy, mixed (calcareous), mesic	Typic Fluvaquents	Entisols.
Poganeab variant.....	Fine-loamy, carbonatic, mesic	Typic Fluvaquents	Entisols.
Pritchett.....	Clayey-skeletal, montmorillonitic	Abruptic Cryic Paleborolls	Mollisols.
Quaker.....	Fine-silty, carbonatic, mesic	Xeric Torrifluvents	Entisols.
Rapho.....	Coarse-loamy, carbonatic, mesic	Xeric Torrifluvents	Entisols.
Ravola.....	Fine-silty, mixed (calcareous), mesic	Typic Torrifluvents	Entisols.
Sanpete.....	Loamy-skeletal, carbonatic, mesic	Xerollic Calciorthids	Aridisols.
Sanpitch.....	Fine-loamy, mixed, frigid	Aridic Calcixerolls	Mollisols.
Sanpitch variant.....	Fine-loamy, mixed, frigid	Xerollic Calciorthids	Aridisols.
Sedwell.....	Fine-loamy, carbonatic, frigid	Pachic Calcixerolls	Mollisols.
Shumway.....	Fine, carbonatic, mesic	Vertic Haplaquepts	Inceptisols.

TABLE 8.—*Classification of soils*—Continued

Series	Family	Subgroup	Order
Sigurd.....	Loamy-skeletal, carbonatic, mesic.....	Xeric Torrifluvents.....	Entisols.
Skumpah.....	Fine-silty, mixed, mesic.....	Typic Natrargids.....	Aridisols.
Skylick.....	Fine, loamy, mixed.....	Cryic Pachic Paleborolls.....	Mollisols.
Snake Hollow.....	Coarse-loamy, mixed, mesic.....	Aridic Haploxerolls.....	Mollisols.
Tingey.....	Fine-loamy, mixed.....	Argic Cryoborolls.....	Mollisols.
Toehead.....	Fine-loamy, mixed, frigid.....	Cumulic Haploxerolls.....	Mollisols.
Toehead variant.....	Fine-loamy, mixed, frigid.....	Torrifluventic Haploxerolls.....	Mollisols.
Toze.....	Fine-loamy, mixed.....	Calcic Pachic Cryoborolls.....	Mollisols.
Wales.....	Fine-loamy, mixed (calcareous), mesic.....	Xeric Torrifluvents.....	Entisols.
Wallsburg.....	Clayey-skeletal, montmorillonitic, frigid.....	Lithic Argixerolls.....	Mollisols.
Watkins Ridge.....	Fine-loamy, mixed, frigid.....	Typic Calcixerolls.....	Mollisols.
Woodrow.....	Fine-silty, mixed (calcareous), mesic.....	Xeric Torrifluvents.....	Entisols.
Yeates Hollow.....	Clayey-skeletal, montmorillonitic, frigid.....	Typic Argixerolls.....	Mollisols.
Zeesix.....	Clayey-skeletal, carbonatic.....	Argic Cryoborolls.....	Mollisols.

SUBGROUP. Great groups are subdivided into subgroups, one representing the central (typic) segment of the group, and others called intergrades that have properties of the group and also one or more properties of another great group, suborder, or order. Subgroups may also be made in those instances where soil properties intergrade outside of the range of any other great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the name of the great group. An example is Typic Fluvaquents (a typical Fluvaquent).

FAMILY. Soil families are separated within a subgroup primarily on the basis of properties important to the growth of plants or to the behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence. A family name consists of a series of adjectives preceding the subgroup name. The adjectives are the class names for texture, mineralogy, and so on, that are used as family differentiae. An example is the fine, mixed (calcareous), mesic family of Typic Fluvaquents.

SERIES. The series consists of a group of soils that formed from a particular kind of parent material and have genetic horizons that, except for texture of the surface soils, are similar in differentiating characteristics and in arrangement in the soil profile. Among these characteristics are color, structure, reaction, consistence, and mineralogical and chemical composition.

Laboratory Data

The results of laboratory analyses of samples are shown by horizons in table 9. Most of the samples were taken from selected modal profiles, and the exceptions are noted. The analyses were made by the Soils Survey Investigations Unit, Riverside, California.

A brief description of methods used in analyzing the soils follows. The code symbols listed with the methods refer to a more detailed description given in Soil Survey Laboratory Methods and Procedures (9). Most of the methods are described therein in enough detail so that they may be followed without other references.

Particle size distribution.—Separation of particles by

size classes and ranges of diameter is determined by pipette and sieve analyses. After treatment of the sample to remove organic matter and soluble salts, particles were dispersed with sodium hexametaphosphate and mechanical shaking (method 3A1). The particle-size data in table 9 in combination with descriptions of soil texture are used to estimate shrink-swell potential, permeability, and other properties of the soils of the Sanpete Valley Area.

Reaction.—The reaction, or pH, measured with a pH meter using a glass electrode (method 8C1). The soil reaction is used to extrapolate from the chemical data reported in table 9 to other soils for which no samples were analyzed.

Organic matter.—Thoroughly decomposed organic material, mostly humus. Estimated from the organic carbon content. Organic matter = organic carbon \times 1.7 (method 6A2C).

Calcium carbonate equivalent.—Total carbonate measured by the volume of carbon dioxide released when the soil is treated with hydrochloric acid (method 6E1b).

Exchangeable sodium.—Percentage of the cation exchange capacity made up of sodium (method 5D2). Percentages of about 15 or more slow the movement of water through the soil and adversely affect the growth of most field crops.

Water content at 1/3 atmosphere.—Water retained by Saran-coated clods wet at 10 cm tension by absorption and then extracted by a pressure plate at 1/3 bar. The water content of the soils at 1/3 bar corresponds fairly closely to field capacity (method 4B1c).

Water content at 15 atmospheres.—Water retained by sieve samples soaked overnight and then equilibrated in a pressure membrane at 15 bars. Water content of samples at 15 bar pressure corresponds fairly closely to the permanent wilting point (method 4B2). In soils that disperse well, the 15-bar ratio of water to clay is about 0.4 to 1.

Bulk density.—Weight of soil per unit volume (method 4A1). Bulk densities of about 1.7 gm/cc or more impede root growth.

Cation exchange capacity.—Capacity of the soil to hold cations in exchangeable form. Measured by the ammonium acetate method at pH 7 (method 5A6a).

TABLE 9.—*Physical and chemical*

[Laboratory analysis by Soils Survey]

Soil	Horizon	Depth	Very coarse sand (2-1 mm)	Coarse sand (1-0.5 mm)	Medium sand (0.5-0.25 mm)	Fine sand (0.25-0.10 mm)	Very fine sand (0.10-0.05 mm)	Silt (0.05-0.002 mm)
		<i>In</i>	<i>Pct</i>	<i>Pct</i>	<i>Pct</i>	<i>Pct</i>	<i>Pct</i>	<i>Pct</i>
Arapien fine sandy loam.	A11	0-2	2.8	6.9	7.0	24.5	22.6	25.7
	A12	2-5	3.3	6.3	6.1	24.0	24.2	25.2
	A13	5-10	2.1	3.9	4.7	23.1	22.8	29.5
	C1ca	10-13	2.9	5.7	6.1	22.2	20.0	26.8
	C2ca	13-20	1.1	2.1	3.4	17.7	17.2	24.8
	C3ca	20-30	3.9	6.4	4.6	15.0	11.9	26.1
	C4ca	30-38	0.7	0.8	1.3	12.4	25.5	35.6
	C5	38-48	1.8	2.5	2.8	18.6	30.3	26.6
	C6	48-61						
Atepic shaly clay loam.	A11	0-2	4.1	3.6	3.6	7.4	7.0	49.6
	A12	2-6	1.9	2.4	2.2	5.2	5.7	51.2
	C1ca	6-11	0.2	0.3	0.2	0.5	0.7	51.7
	C2ca	11-17	0.1	0.1	0.1	0.1	0.2	60.0
	C3	17-40	0.2	0.1		0.2	0.3	68.6
	R	40-44	0.1	0.3	0.2	0.5	0.6	63.1
Borvant cobbly loam.	A11	0-3	8.9	9.9	7.6	12.2	9.5	29.5
	A12	3-8	7.8	7.1	5.7	11.1	10.2	32.1
	A13	8-14	8.2	7.5	6.1	9.8	8.3	29.4
	C1ca	14-19	16.6	11.4	6.2	9.6	7.3	22.6
	C2cam	19-30	19.5	13.4	7.5	12.2	10.2	22.7
	C3cam	30-38	25.4	15.4	8.0	12.6	9.8	16.6
	C4ca	38-48	16.6	16.1	9.7	16.4	10.5	24.1
	C5	48-60	18.5	16.2	8.3	15.0	11.0	22.5
Ephraim silty clay loam.	A11	0-6	0.8	0.8	1.2	5.1	7.8	54.4
	A12	6-13	0.1	0.4	0.6	3.6	7.5	57.7
	C1	13-21	0.0	0.2	0.4	2.7	6.4	58.0
	C2	21-30	0.0	0.1	0.2	1.7	6.5	58.8
	A13b	30-33	0.1	0.1	0.1	0.4	1.5	49.4
	A13b	33-35	0.0	0.1	0.0	0.3	0.7	54.2
	A12b	35-37	0.0	0.1	0.1	1.1	3.8	53.7
	C3	37-41	0.1	1.1	2.1	10.1	12.0	45.2
	A14b	41-51	0.0	0.3	0.7	4.3	8.3	44.4
	C4	51-62	0.1	0.5	1.0	6.2	12.8	51.0
Fontreen very cobbly loam.	A11	0-4	3.0	2.7	1.6	6.4	14.7	47.2
	A12	4-7	4.8	3.2	1.5	5.2	10.5	49.3
	A13	7-15	5.5	4.2	2.0	4.5	9.1	45.7
	C1ca	15-21	5.1	4.8	2.5	6.0	10.3	43.2
	C2ca	21-29	7.4	5.8	2.7	5.9	9.8	40.7
	C3ca	29-44	12.0	7.9	3.8	7.4	11.2	37.7
	C4ca	44-58	11.8	8.2	3.9	8.8	13.1	42.8
	C5	58-66	8.8	6.3	2.9	7.2	15.5	50.8
Genola loam.	Ap1	0-7	0.2	0.3	1.0	11.8	20.1	42.1
	Ap2	7-13	0.1	0.4	1.0	10.4	18.9	43.6
	C1	13-19	0.0	0.2	0.3	6.6	26.6	48.6
	C2	19-23	0.0	0.3	0.4	5.0	25.1	54.6
	A1b	23-31	0.0	0.1	0.1	2.0	10.4	52.8
	C3	31-34	0.0	0.1	0.2	2.5	10.8	64.9
	C4	34-37	0.0	0.2	1.3	10.3	13.8	47.9
	C4	37-40	0.0	0.3	3.7	26.5	25.5	31.3
	C4	40-42	0.0	0.2	0.4	8.3	10.1	55.1
	C5	42-45						
	C6	45-47						
Lisade loam.	A11	0-2	8.5	10.2	8.0	12.9	11.8	37.5
	A12	2-5	7.2	10.5	9.1	14.0	10.3	33.4
	C1ca	5-12	8.8	13.4	10.2	10.6	8.0	28.9
	C2ca	12-16	11.4	18.1	14.0	13.6	9.2	24.4
	C3ca	16-22	9.9	17.0	14.7	19.1	11.8	20.0
	C4	22-30	11.9	15.4	13.4	17.1	10.4	20.3
	C5	30-34	12.1	13.4	9.6	13.4	8.8	24.7
	IIC6	34-49	5.2	8.9	9.6	21.6	15.6	27.0

analyses of selected soils

Investigations Unit, Riverside, Calif.]

Clay (<0.002 mm)	Reaction (saturated paste)	Organic matter	Calcium carbonate equivalent	Exchange- able sodium	Water content at 1/3 atm	Water content at 15 atm	Bulk density moist	Cation exchange capacity
Pct	pH	Pct	Pct	Pct	Pct	Pct	Gm per cc	Meq per 100 gm of soil
10.5	7.9	1.0	19	1	20.8	6.6	1.39	9.8
10.9	7.9	0.8	18	1	17.2	6.0	1.40	9.7
13.9	7.8	-----	15	1	20.2	6.8	1.43	9.8
16.3	8.0	-----	35	4	28.2	8.6	-----	7.9
33.7	7.8	-----	41	59.7	32.5	9.5	1.20	6.5
32.1	8.1	-----	53	61.8	27.8	10.6	1.61	5.1
23.7	7.9	-----	30	62.0	15.3	7.5	1.67	5.0
17.4	8.0	-----	25	38.2	12.3	5.9	1.60	6.0
					17.3	6.7	1.28	-----
24.7	7.9	2.3	39	1	-----	10.3	-----	17.2
31.4	8.0	3.1	37	0	24.9	12.0	1.06	20.7
46.4	8.1	2.4	42	1	26.9	15.2	1.31	24.9
39.4	8.3	0.5	70	1	23.7	11.6	1.48	14.0
30.6	8.4	0.1	50	3	21.9	12.0	1.59	16.2
35.2	8.5	0.4	80	8	19.9	10.0	1.70	8.5
22.4	8.1	3.1	35	1	-----	11.3	-----	15.2
26.0	7.9	3.1	37	1	20.1	12.8	1.12	17.5
30.7	8.0	1.2	50	1	-----	15.3	-----	16.1
26.3	8.0	1.2	86	2	21.7	15.2	1.46	6.0
14.5	8.3	1.0	83	2	21.0	10.5	1.54	5.6
12.2	8.3	1.4	68	3	23.5	14.4	1.44	6.7
6.6	8.5	0.3	33	1	22.7	9.0	1.29	18.9
8.5	8.4	5.8	-----	1	24.5	9.4	1.37	21.3
29.9	7.4	3.5	47	3	27.0	12.5	1.25	15.3
30.1	7.6	1.5	51	2	26.2	10.8	1.26	13.3
32.3	7.8	1.1	54	1	24.8	14.6	1.32	13.6
32.7	7.9	1.1	51	1	20.9	14.0	1.56	14.2
48.4	7.9	1.4	48	0	-----	15.0	-----	20.6
44.7	7.9	-----	50	1	-----	13.6	-----	19.1
41.2	7.9	1.4	50	1	-----	13.2	-----	18.6
29.4	7.9	1.0	44	1	-----	9.5	-----	13.7
42.0	8.0	-----	36	1	20.9	14.4	1.51	17.5
28.4	8.1	-----	49	1	16.1	9.0	1.21	11.2
24.4	7.7	6.3	30	-----	-----	16.4	-----	24.1
25.5	7.6	5.9	31	-----	42.7	15.9	0.90	24.2
29.0	7.6	5.6	35	-----	51.8	18.3	0.82	24.8
28.1	7.6	3.5	53	1	42.0	19.0	-----	16.0
27.7	7.7	1.9	65	1	34.4	16.5	0.97	11.7
20.0	8.1	1.8	64	1	-----	12.1	0.59	11.2
11.4	8.4	1.3	61	1	41.0	12.0	0.96	10.2
8.5	8.3	0.8	39	1	31.3	12.8	0.98	14.2
24.5	8.1	1.4	25	6	19.0	10.5	1.35	12.3
25.6	8.1	3.2	26	5	19.4	11.3	1.37	13.0
17.7	8.2	0.6	29	6	20.8	7.4	1.34	11.1
14.6	8.2	0.5	25	8	22.7	7.6	1.37	11.2
34.6	8.2	0.4	38	7	19.5	13.1	1.39	17.4
21.5	8.2	0.4	32	8	21.9	9.0	1.33	15.9
26.5	8.2	0.4	33	8	15.2	10.3	1.39	13.8
12.7	-----	0.3	28	11	17.4	5.0	1.42	7.5
25.9	-----	0.4	35	8	19.5	11.3	1.33	14.6
-----	-----	0.3	26	-----	13.2	2.6	1.41	-----
-----	-----	0.4	43	-----	21.9	10.1	1.39	-----
11.1	7.6	1.6	44	-----	22.7	9.2	1.28	9.2
15.5	8.0	1.7	48	1	27.2	12.6	1.15	9.3
20.1	8.1	1.0	58	2	36.2	14.4	1.11	4.7
9.3	8.3	-----	49	5	32.9	10.5	1.20	5.9
7.5	8.5	-----	39	11	21.1	10.4	1.31	7.3
11.5	8.7	-----	40	16	22.6	9.6	1.29	7.5
18.0	8.6	-----	45	30	21.3	10.2	1.28	8.2
12.1	8.5	-----	32	33	12.6	7.0	1.60	5.6

TABLE 9.—Physical and chemical

Soil	Horizon	Depth	Very coarse sand (2-1 mm)	Coarse sand (1-0.5 mm)	Medium sand (0.5-0.25 mm)	Fine sand (0.25-0.10 mm)	Very fine sand (0.10-0.05 mm)	Silt (0.05-0.002 mm)
		In	Pct	Pct	Pct	Pct	Pct	Pct
Mayfield shaly loam.	A11	0-2	2.9	5.6	5.2	12.2	12.5	46.9
	A12	2-5	5.3	6.0	3.3	7.4	9.1	51.9
	C1	5-11	6.4	6.8	3.6	7.6	10.1	44.7
	C2	11-22	7.9	8.0	3.6	6.5	8.7	44.7
	C3	22-30	2.3	4.6	3.7	9.1	12.6	46.6
	C4	30-45	4.2	6.1	4.3	9.2	11.8	45.7
	C5	45-56						
Mortenson silt loam.	A21	0-4						
	A22	4-12						
	A23	12-28						
	A&B	28-34						
	B21t	34-42						
	B22t	42-49						
	B23t	49-60						
Mower clay loam.	A11	0-2	1.4	1.4	1.4	2.8	4.3	46.9
	A12	2-11	1.1	1.4	1.1	2.2	2.7	44.7
	B2	11-17	0.1	0.3	0.5	1.1	1.4	45.5
	C1ca	17-25	0.4	0.6	0.8	1.6	1.4	60.1
	C2ca	25-35	0.1	0.8	1.3	2.0	1.7	65.7
	R							
Quaker silty clay loam. (Not modal profile but representative of series)	Ap	0-6	0.2	0.4	0.9	5.0	6.9	57.7
	C1	6-17	0.0	0.2	0.4	3.8	7.3	57.3
	C2	17-27	0.0	0.2	0.4	2.1	5.0	60.3
	C3	27-35	0.1	0.5	1.1	3.3	4.8	56.7
	C4	35-36	0.1	0.1	0.2	1.6	2.1	60.4
	C5	36-44	0.1	0.4	0.8	3.1	5.0	57.4
	C6	44-52	0.1	0.5	1.2	5.5	6.5	57.4
	C7	52-60	0.1	0.4	0.9	3.7	5.4	58.4
Skumpah silt loam.	A21	0-1	0.0	0.1	0.1	3.5	34.3	53.0
	A22	1-3	0.1	0.1	0.2	3.6	31.2	54.0
	B2t	3-7	0.1	0.1	0.2	1.9	11.9	51.1
	B3	7-13	0.0	0.1	0.3	2.7	8.1	56.9
	C1cs	13-27	0.1	0.3	0.3	4.6	19.7	49.3
	C2cs	27-39	0.0	0.1	0.2	4.0	18.0	54.0
	C3	39-45	0.1	0.3	0.6	5.1	27.2	53.0
	C4cs	45-60	0.1	0.1	0.3	5.2	24.0	50.0
Skylick silt loam.	A11	0-5						
	A12	5-17						
	A13	17-27						
	B21t	27-42						
	B22t	42-52						
	B23t	52-66						

Climate ³

The climate of the Sanpete Soil Survey Area is markedly influenced by the large variations in topography. A major part of the region consists of the drainage of the Sanpitch River and its confluence with the Sevier River. In general, the elevation of the valley floor ranges from 5,100 to 5,800 feet above sea level, but the adjacent mountains bordering the valley rise to well over 9,000 feet.

These mountains act as a barrier to the moisture associated with eastward-moving Pacific storm fronts, and the valley climate is semi-arid continental in spite

of its high elevation. The average annual precipitation ranges from about 8 inches in the lower part of the valley to more than 30 inches in the higher mountains. Most of the annual precipitation is in the form of snow. Snow depth averages from about 40 inches a year in the bottom of the valley to near 200 inches in the highest mountains.

Winter moisture, from October through April, ranges from 8 inches in the valley to more than 20 inches at higher elevations in the mountains. Summer moisture from May through September is mainly the result of thunderstorms which form in the moist air from the Gulf of Mexico. The amount of summer moisture is about half that received in winter and ranges from 4 inches in the lower part of the valley to 8 inches in the mountains.

³ E. ARLO RICHARDSON, climatologist for Utah, assisted in the preparation of this section.

analyses of selected soils—Continued

Clay (<0.002 mm)	Reaction (saturated paste)	Organic matter	Calcium carbonate equivalent	Exchange- able sodium	Water content at 1/3 atm	Water content at 15 atm	Bulk density moist	Cation exchange capacity
Pct	pH	Pct	Pct	Pct	Pct	Pct	Gm per cc	Meq per 100 gm of soil
14.7	7.6	2.0	49	10	14.6	7.7	1.34	8.3
17.0	7.9	1.4	50	6	16.5	7.8	1.40	7.0
20.8	7.5	0.7	52	1	17.9	8.9	1.24	8.0
20.6	7.4	0.7	44	-----	19.8	9.3	1.26	10.2
21.1	7.6	0.9	45	5	19.4	9.0	1.33	12.9
18.7	7.8	0.5	50	2	19.1	8.4	1.35	6.6
-----	-----	0.4	-----	2	20.9	10.7	1.35	-----
-----	5.9	6.3	-----	67	17.8	8.1	1.09	16.8
-----	5.4	1.7	-----	52	15.0	4.8	1.38	10.7
-----	5.7	0.9	-----	68	12.1	4.6	1.40	7.7
-----	6.5	0.9	-----	98	15.5	10.1	1.52	17.0
-----	6.6	0.7	-----	94	17.7	10.1	1.61	18.6
-----	6.5	0.6	-----	92	18.4	10.1	1.58	19.1
-----	1.6	0.4	1	100	17.7	9.5	1.63	18.5
41.8	7.9	6.5	36	0	26.4	16.1	1.12	26.4
46.8	7.8	4.9	42	0	25.0	16.5	1.19	23.4
51.1	8.0	3.2	50	1	26.8	16.9	1.35	19.3
35.1	8.2	2.0	77	1	28.7	12.7	1.36	12.3
28.4	8.6	0.5	86	2	24.7	9.3	1.49	5.3
-----	9.0	0.4	91	6	-----	-----	-----	1.7
28.9	8.8	1.5	36	0	18.1	10.8	1.33	13.0
31.0	8.2	1.4	42	0	18.2	10.8	1.30	12.0
32.0	8.3	1.1	43	1	19.5	11.6	1.34	12.1
33.5	8.4	1.0	43	1	20.5	11.6	1.36	12.7
35.5	8.4	1.3	40	1	25.4	12.5	1.25	14.7
33.2	8.6	0.8	41	1	20.9	11.4	1.34	12.2
28.8	8.5	0.7	-----	2	19.4	10.6	1.34	11.5
31.1	8.5	-----	-----	7	21.9	11.5	1.35	12.0
10.0	8.8	0.9	17	5	-----	-----	-----	5.8
11.0	8.8	0.9	18	5	-----	-----	-----	5.8
34.7	8.8	0.5	19	11	-----	-----	-----	11.3
31.9	8.6	0.5	19	15	-----	-----	-----	12.7
25.7	8.4	0.5	18	9	-----	-----	-----	10.0
23.0	8.5	0.3	18	9	-----	-----	-----	8.3
14.0	8.5	0.3	20	7	-----	-----	-----	8.3
21.0	8.2	0.2	-----	6	-----	-----	-----	6.8
-----	6.4	14.7	-----	100	38.3	27.0	0.85	46.6
-----	6.8	7.2	-----	100	32.9	15.8	0.96	31.6
-----	6.8	5.0	-----	94	28.1	12.1	1.18	25.1
-----	6.9	0.9	-----	97	18.7	10.6	1.57	16.7
-----	7.0	0.9	-----	95	19.4	9.8	1.56	16.8
-----	7.3	0.6	-----	98	18.4	9.5	1.45	18.7

The frost-free period ranges from 120 days in the lower part of the valleys to 40 days or less at higher elevations. Winters are cold but not severe. About 175 days each year at lower elevations the minimum temperatures are below 32° F. A few days each year have a sub-zero minimum in most localities. The coldest temperatures recorded in the valley range from -25° to -35° F, but they are quite rare.

Summers are very mild, and maximum temperatures are generally in the 80's. Maximums of 90° are reported for some 20 days a year, and 100° temperatures are very rare.

Winds are generally light in all seasons and are normally less than 15 miles per hour. The prevailing winds are associated with the drainage of cold air from the higher elevations. During the night and early

morning hours the cold, heavy air which has been cooled by radiation from the high mountainsides flows down into the valley. During the daytime, as the mountainsides are heated by the sun, a reverse action takes place and the heated air rises.

As storm fronts move across the area, the stronger winds associated with these fronts overrule the lighter drainage winds. Occasional damaging winds occur with these fronts. Some damaging winds occur during the summer months in association with active thunderstorms. Hailstones, although normally small in size, also cause some damage to crops and property during the late spring and summer months.

Data on the temperature and precipitation for the survey area are given in table 10 for the Manti and Birdseye stations. The probability, in percent, and

TABLE 10.—*Climate and precipitation*

[At Manti, data are for the period 1936 to 1965. At Birdseye, precipitation data are for 1934 to 1971; temperature data for 1941 to 1970]

Month	Temperature			Precipitation					
	Mean daily maximum	Mean daily minimum	Mean monthly	Mean	Greatest daily	Year	Snow		
							Mean	Maximum monthly	Year
	°F	°F	°F	Inches	Inches	Inches	Inches	Inches	Inches
Manti, elevation 5,515 feet									
January	36.9	13.6	25.3	1.09	1.02	1953	12.1	24.3	1957
February	41.3	17.8	29.6	1.30	.84	1953	11.4	32.3	1960
March	50.3	23.9	37.1	1.44	1.02	1957+	11.1	35.7	1961
April	61.3	32.2	46.8	1.26	.78	1963+	3.3	17.0	1957
May	70.5	39.0	54.8	1.11	1.52	1937	1.3	11.0	1964
June	79.4	45.1	62.3	.93	1.75	1943	0	0	
July	86.8	52.9	69.9	.81	1.20	1953	0	0	
August	85.0	52.1	68.5	.93	1.28	1946	0	0	
September	77.5	43.8	60.7	.92	1.23	1965	(¹)	10.0	1965
October	66.2	34.6	50.4	1.10	1.05	1946	.7	7.0	1949
November	49.9	23.5	36.7	.97	.72	1942	5.7	25.0	1951
December	40.4	17.3	28.9	1.13	1.12	1951	9.1	23.5	1949
Annual	62.1	32.5	47.3	12.99	1.75	June 1943	54.7	35.7	March 1961
Birdseye, elevation 5,740 feet									
January	35.0	6.4	20.7	1.44	1.93	1965	16.5	39.0	1969
February	38.6	10.5	24.6	1.40	1.15	1937	13.2	31.0	1940
March	47.1	17.1	32.1	1.21	1.09	1935	10.5	43.0	1952
April	58.5	25.5	42.0	1.02	.90	1935	3.5	17.0	1963
May	69.5	29.9	49.7	.94	1.16	1937	.8	11.5	1964
June	78.2	35.9	57.1	.80	1.43	1943	(¹)	(¹)	1955
July	87.0	40.9	64.0	.89	1.05	1951	0	0	
August	85.6	40.0	62.8	1.14	.88	1965	0	0	
September	77.3	32.0	54.7	.86	.81	1947	.3	10.0	1965
October	65.7	24.3	45.0	1.02	1.24	1939	1.0	9.0	1961
November	48.4	16.8	30.8	1.01	1.34	1955	6.0	17.0	1934
December	38.5	8.9	23.7	1.49	1.77	1951	13.3	36.5	1936
Annual	60.8	24.0	42.3	13.22	1.93	Jan. 1969	65.1	43.0	March 1952

¹ Trace.

probable dates that specified temperatures occur at the Manti station in spring and fall are shown in figure 16.

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Glossary

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as crumbs, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

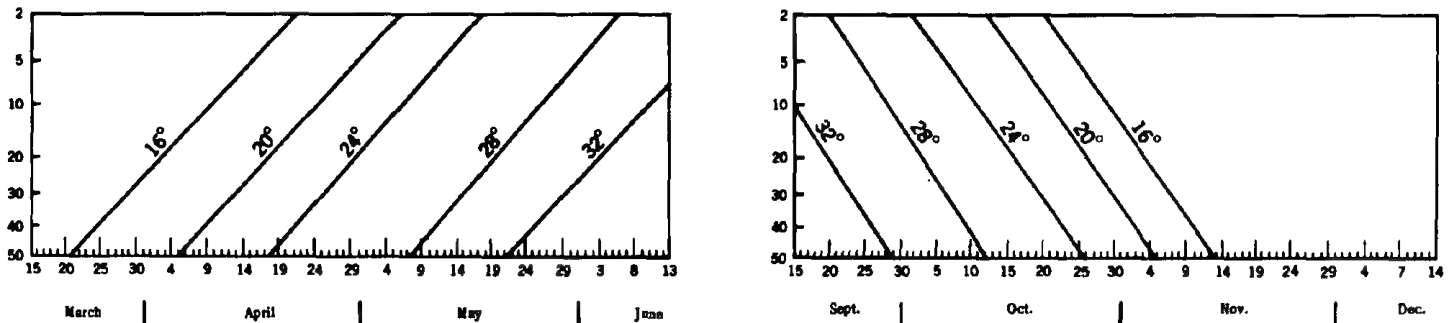


Figure 16.—Probabilities, in percent, and probable dates of last freezing temperature in spring and first in fall for Manti, Utah.

Alkali soil. Generally, a highly alkaline soil. Specifically, an alkali soil has so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that the growth of most crop plants is low from this cause.

Alluvial fan. A fan-shaped deposit of sand, gravel, and fine material dropped by a stream where the gradient lessens abruptly. In the survey area, some alluvial fans are cone shaped and are at the base of mountains.

Alluvial plain. A series of alluvial fans that have coalesced.

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern.

Available water capacity (also termed available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

Border irrigation. A method of irrigation in which the lateral surface flow of water is controlled with small earth ridges, called border dikes.

Calcareous soil. A soil that contains enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold dilute hydrochloric acid. The following are terms used in this soil survey to describe calcareous soils, and the approximate amounts of lime these soils contain:

Slightly calcareous ----- 1 to 3 percent lime.
Moderately calcareous ----- 3 to 15 percent lime.
Strongly calcareous ----- 15 to 40 percent lime.
Very strongly calcareous ----- 40 percent lime or more.

Calcic horizon. A horizon that contains an accumulation of calcium carbonate or of calcium and magnesium carbonates. The letter designation "ca" is used to indicate such a horizon.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Coarse fragments. The gravel, cobbles, or stones in a soil ranging in size from 2 mm. in diameter to 3 feet.

Cobblestones. Rounded fragments of minerals or rocks between 3 and 10 inches in diameter.

Cobby soil. A soil that is 20 to 50 percent coarse fragments, dominantly the size of cobblestones.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure

but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Drainage class (natural). Refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized.

Excessively drained soils are commonly very porous and rapidly permeable and have a low available water capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and mottling in the lower B and the C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and some soils commonly have mottling at a depth below 6 to 16 inches.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the oven-dry weight, after the gravitational, or free, water has been allowed to drain away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity*, *normal moisture capacity*, or *capillary capacity*.

Flood plain. Nearly level land, consisting of stream sediments, that borders a stream and is subject to flooding unless protected artificially.

Furrow irrigation. A method of irrigating crops by the use of small closely spaced ditches.

Gravelly soil. A soil in which 20 to 50 percent of the solum is coarse fragments between $\frac{1}{4}$ inch and 3 inches in diameter. A very gravelly soil is one in which more than 50 percent of the solum is coarse fragments the size of gravel.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Leaching. The removal of soluble materials from soils or other material by percolating water.

Lime. Strictly calcium oxide (CaO), but as commonly used in agricultural terminology, calcium carbonate.

Loamy. A grouping of the medium textured soils including loam, silt loam, and very fine sandy loam.

Light loamy.—A grouping of the moderately coarse textured soils including fine sandy loam and sandy loam.

Heavy loamy.—A grouping of the moderately fine textured soils including clay loam, silty clay loam, and sandy clay loam.

Mottling, soil. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: abundance—*few, common, and many*; size—*fine, medium, and coarse*; and contrast—*faint, distinct, and prominent*. The size measurements are these: *fine*, less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium*, ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse*, more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Munsell notation. A system for designating color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with a hue of 10YR, a value of 6, and a chroma of 4.

Nutrient, plant. Any element taken in by a plant, essential to its growth, and used by it in the production of food and tissue. Nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, zinc, and perhaps other elements obtained from the soil and carbon, hydrogen, and oxygen obtained largely from the air and water, are plant nutrients.

Parent material. Disintegrated and partly weathered rock from which soil has formed.

Permeability. The quality that enables the soil to transmit water or air. Terms used to describe permeability are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid, and very rapid*.

pH value. A numerical means for designating acidity and alkalinity in soils. A pH value of 7.0 indicates precise neutrality; a higher value, alkalinity; and a lower value, acidity.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Range site. An area of range where climate, soil, and relief are sufficiently uniform to produce a distinct kind of climax vegetation.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH		pH
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.5	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Roots (abundance of). Following are terms used to describe abundance of roots: many, more than 25 percent of the surface area is penetrated; common, 3 to 25 percent of the surface area is penetrated; few, less than 3 percent of the surface area is penetrated.

Saline soil. A soil that contains soluble salts in quantities that impair its productivity for plants, but that does not contain an excess of exchangeable sodium. Following are terms for degrees of salinity:

Slightly saline.—The conductivity of the saturation extract of soils is 4 to 8 millimhos within 30 inches of the surface.

Moderately saline.—The conductivity of the saturation extract of the soils is 8 to 16 millimhos within 30 inches of the surface.

Strongly saline.—The conductivity of the saturation extract is more than 16 millimhos within 30 inches of the surface.

Moderately saline-alkali.—Conductivity of the saturation extract of the soils is more than 12 millimhos, and more than 35 percent of the specified area consists of soils that are 15 to 30 percent exchangeable sodium within 30 inches of the surface.

Strongly saline-alkali.—The conductivity of the saturation extract of the soils is more than 12 millimhos within 30 inches of the surface, and more than 10 percent of the specified area consists of soils that are more than 30 percent exchangeable sodium within 30 inches of the surface.

Sand. Individual rock or mineral fragments in a soil that range in diameter from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Slope classes. The following slope classes are used in this soil survey:

Nearly level	0 to 1 percent.
Gently sloping	1 to 3 percent.
Moderately sloping	3 to 6 percent.
Strongly sloping	6 to 10 percent.
Moderately steep	10 to 16 percent.
Steep	16 to 30 percent.
Very steep	More than 30 percent.

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Sprinkler irrigation. A method of irrigating crops by the use of sprinklers.

Stones. Coarse fragments more than 10 inches in diameter.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles) adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. Technically, the part of the soil below the solum.
Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

Terrace (geological). An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Coarse-textured soil. A soil that contains a large proportion of sand, that is loose and noncoherent when dry, and is generally relatively low in fertility and in available moisture capacity; highly erodible. Coarse-textured soils are sands and loamy sands.

Moderately coarse textured soil. A soil that has a high content of sand but that contains enough silt and clay to

form fragile aggregates; individual grains of sand are easily seen, and the soil mass feels gritty; highly erodible. Moderately coarse textured soils are sandy loams and fine sandy loams.

Medium-textured soil. A soil that generally is friable and easily tilled. Medium-textured soils are very fine sandy loams, loams, silt loams, and silts.

Moderately fine textured soil. A soil that has a texture intermediate between fine and medium. Moderately fine textured soils are clay loams, sandy clay loams, and silty clay loams.

Fine-textured soil. A soil that contains a large proportion of clay; it is normally hard when dry and plastic when wet. Fine-textured soils are sandy clays, silty clays, and clays.

Water-supplying capacity. The amount of water that is stored in the soil during periods of plant dormancy plus what is added in precipitation during the growing season. The amount available to plants from the start of the growing season until moisture is depleted.

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

GUIDE TO MAPPING UNITS

[Wildlife groups are described on pages 116 and 117]

Wildlife groups are described on pages 110 and 1171										Wildlife
Capability unit										suita-
Described Irrigated Nonirrigated										bility
Range site										group
Map	Mapping unit	on	Symbol	Page	Symbol	Page	Name	Page	Number	
symbol		page								
Aa	Abcal silty clay loam---	11	-----	--	Vw-2	97	Wet Meadows	113	3212	
Ab	Abcal silty clay loam, strongly saline-----	11	-----	--	VIIw-28	100	Salt Meadows	107	4424	
Ac	Abcal-Cache complex-----	11	-----	--	VIIw-28	100	Salt Meadows	107	4424 4434	
ADG	Adel silt loam, 40 to 80 percent slopes-----	11	-----	--	VIIe-H	99	High Mountain Loam	104	3141	
AEE	Amtoft flaggy loam, 8 to 30 percent slopes-----	12	-----	--	VIIIs-S	100	Semi-desert Shallow Loam	109	4343	
AFG2	Amtoft-Rock outcrop com- plex, 30 to 60 percent slopes, eroded-----	12	-----	--	VIIIs-S	100	Semi-desert Shallow Loam	109	4343	
Ag	Anco silty clay loam----	13	IIIw-2	96	-----	---	-----	---	2121-I 2121	
AHD	Ant Flat stony loam, 8 to 25 percent slopes--	14	-----	--	VIe-M	98	Mountain Loam	106	2141	
AHE2	Ant Flat stony loam, 25 to 40 percent slopes, eroded-----	14	-----	--	VIe-M	98	Mountain Loam (Oak)	106	2141	
AkC	Ant Flat loam, low rain- fall, 4 to 8 percent slopes-----	14	-----	--	IIIe-U	96	Upland Loam	110	2141	
ALD	Ant Flat-Borvant com- plex, 4 to 25 percent slopes-----	14	-----	--	VIIs-U	99	Upland Loam	110	2141	
	Ant Flat soil-----	--	-----	--	-----	---	Upland Shallow	111	3242	
	Borvant soil-----	--	-----	--	-----	---	Hardpan (Juniper-Pinon)			
AmB	Arapien fine sandy loam, 1 to 2 percent slopes-	15	IIe-2	95	VIIe-S	99	Semi-desert Limy Loam	108	1141-I 3342	
AmC2	Arapien fine sandy loam, 2 to 5 percent slopes, eroded-----	15	IIIe-2	95	VIIe-S	99	Semi-desert Limy Loam	108	1141-I 3342	
AmD2	Arapien fine sandy loam, 5 to 10 percent slopes, eroded-----	15	IVe-2	97	VIIe-S	99	Semi-desert Limy Loam	108	3342	
AnB	Arapien fine sandy loam, saline-alkali, 1 to 2 percent slopes-----	16	-----	--	VIIw-28	100	Alkali Bottoms	104	4434	
AoB	Arapien fine sandy loam, wet, 1 to 2 percent slopes-----	16	IIIw-2	96	VIw-2	98	Semi-wet Meadows	110	2121-I 2121	
ApC2	Arapien clay loam, grav- elly subsoil, 2 to 5 percent slopes, eroded-----	16	IIIe-2	95	VIIe-S	99	Semi-desert Limy Loam	108	1141-I 3342	
ARD	Arapien-Calita complex, 2 to 15 percent slopes-----	16	-----	--	IVe-UZ	97	Upland Loam	110	3242	

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Described on page	Capability unit		Range site	Page	Wildlife suita- bility group
			Irrigated	Nonirrigated			
			Symbol	Page	Name		Number
ASE2	Atepic shaly clay loam, 10 to 30 percent slopes, eroded-----	17	----- --	VIIIs-U 101	Upland Shallow Shale (Juniper-Pinon)	112	4343
ATF	Atepic very cobbly silty clay loam, 8 to 40 percent slopes-----	17	----- --	VIIIs-U 101	Upland Shallow Shale (Juniper-Pinon)	112	4343
AUF	Atepic clay loam, red variant-Rock outcrop complex, 30 to 50 percent slopes-----	18	----- --	VIIIs-S 100	Semi-desert Shallow Loam	109	4343
AV	Atepic-Badland associa- tion----- Atepic soil-----	18 --	----- --	VIIIs-U 101	Upland Shallow Shale (Juniper-Pinon)	112	4343
BA	Badland-----	--	----- --	VIIIe-E 101	-----	---	----
BCE	Badland-----	18	----- --	VIIIe-E 101	-----	---	----
BCE	Bagard very stony clay loam, 10 to 40 percent slopes-----	19	----- --	VIIIs-U 101	Upland Stony Loam (Juniper-Pinon)	112	3242
BDE	Bagard-Sanpitch complex, 8 to 40 percent slopes-----	19	----- --	VIIIs-U 101	Upland Stony Loam (Juniper-Pinon)	112	3242
Be	Beek silty clay loam----	20	IIIw-2 96	VIw-2 98	Semi-wet Meadows	110	2121-I 2121
BFD	Bezzant cobbly loam, 4 to 25 percent slopes--	21	IVs-24 97	VIIs-U 99	Upland Stony Loam	111	3242
BGE	Bezzant stony loam, 25 to 40 percent slopes--	21	----- --	VIIs-U 99	Upland Stony Loam	111	3242
BH	Bezzant-Gappmayer-Rock land association, very steep----- Bezzant soil----- Gappmayer soil----- Rock land-----	21 -- -- --	----- -- ----- -- ----- -- ----- --	VIIIe-X 101 VIIIe-X 101 VIIIs-X 101	----- ----- -----	---	----
Bm	Billings silty clay loam-----	22	IIIe-25 96	VIIIe-S 99	Semi-desert Loam	109	1141-I 3342
BnB	Birdow very fine sandy loam, 2 to 4 percent slopes-----	22	IIe-2 95	IVe-UZ 97	Upland Loam	110	1141-I 3242
BnC	Birdow very fine sandy loam, 4 to 8 percent slopes-----	23	IIIe-2 95	IVe-UZ 97	Upland Loam	110	1141-I 3242
BoB	Birdow silt loam, 2 to 4 percent slopes-----	23	IVs-24 97	----- --	-----	---	1141-I
BRD2	Borvant cobbly loam, 8 to 25 percent slopes, eroded-----	23	----- --	VIIIs-U 101	Upland Shallow Hardpan (Juniper-Pinon)	111	3242

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Described on page	Capability unit		Range site		Wildlife suita- bility group
			Irrigated	Nonirrigated			
			Symbol	Page	Symbol	Page	Page
BSE2	Borvant-Bagard complex, 10 to 40 percent slopes, eroded----- Borvant soil-----	24	-----	--	VIIs-U	101	-----
							Upland Shallow Hardpan (Juniper-Pinon)
							111
	Bagard soil-----	--	-----	--	-----	--	Upland Stony Loam (Juniper-Pinon)
							112
BTC	Borvant-Doyce complex, 2 to 10 percent slopes----- Borvant soil-----	25	-----	--	VIIs-U	99	-----
							Upland Shallow Hardpan (Juniper-Pinon)
							111
	Doyce soil-----	--	-----	--	-----	--	Upland Loam
							110
BUD2	Borvant-Lodar complex, 8 to 25 percent slopes, eroded----- Borvant soil-----	25	-----	--	VIIs-U	101	-----
							Upland Shallow Hardpan (Juniper-Pinon)
							111
	Lodar soil-----	--	-----	--	-----	--	Upland Shallow Loam (Juniper- Pinon)
							112
BVG	Bradshaw very stony loam, 60 to 80 per- cent slopes-----	26	-----	--	VIIIe-X	101	-----
							3242
CaB	Calita loam, 2 to 4 percent slopes-----	27	IIe-2	95	IVe-UZ	97	Upland Loam
							110
							1141-I 3242
CaC	Calita loam, 4 to 8 percent slopes-----	27	IIIe-2	95	IVe-UZ	97	Upland Loam
							110
							1141-I 3242
Cb	Canburn silty clay loam-----	28	-----	--	Vw-2	97	Wet Meadows
							113
CcB	Centerfield silty clay loam, 1 to 2 percent slopes-----	28	IIe-2	95	VIIe-S	99	Semi-desert Loam
							109
							1141-I 3342
CcC2	Centerfield silty clay loam, 2 to 5 percent slopes, eroded-----	29	IIIe-2	95	VIIe-S	99	Semi-desert Loam
							109
							1141-I 3342
CDG	Cheadle very flaggy silt loam, 40 to 70 percent slopes-----	29	-----	--	VIIs-M	100	Mountain Shallow Loam
							107
							3242
Ch	Chipman silty clay loam-----	30	-----	--	Vw-2	97	Wet Meadows
							113
							3212
Cm	Chipman complex-----	30	-----	--	Vw-2	97	Wet Meadows
							113
							3212
CNC	Clegg loam, 3 to 10 percent slopes-----	31	-----	--	IIIe-M	96	Mountain Loam
							106
							2141
CoC	Collard gravelly sandy loam, 4 to 8 percent slopes-----	32	IVs-24	97	VIIs-U	99	Upland Stony Loam
							111
							3242-I 3242
CRD	Collard stony sandy loam, 4 to 20 percent slopes-----	32	-----	--	VIIs-U	99	Upland Stony Loam (Juniper-Pinon)
							112
							3242

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Described on page	Capability unit		Range site		Wildlife suita- bility group		
			Symbol	Page	Symbol	Page		Name	Page
CsC	Crestline fine sandy loam, 2 to 5 percent slopes-----	33	-----	--	VIe-S	98	Semi-desert Loam	109	3342
CU	Cryoborolls-----	33	-----	--	VIIe-H	99	High Mountain Stony Loam (Aspen)	105	3141
DAG	Daybell gravelly silt loam, 40 to 70 percent slopes-----	34	-----	--	VIIe-H	99	High Mountain Stony Loam (Aspen)	105	3141
DBG	Daybell-Flygare association, very steep--	34	-----	--	-----	---	-----	---	3141
	Daybell soil-----	--	-----	--	VIIe-H	99	High Mountain Stony Loam (Aspen)	105	
	Flygare soil-----	--	-----	--	VIIIs-HC	100	-----	---	
DcD	Deer Creek stony silt loam, 6 to 30 percent slopes-----	35	-----	--	VIe-U	98	Upland Loam	110	2141
DED	Deer Creek stony silt loam, high rainfall, 6 to 25 percent slopes-----	35	-----	--	VIe-M	98	Mountain Loam (Oak)	106	2141
DEE	Deer Creek stony silt loam, high rainfall, 25 to 40 percent slopes-----	36	-----	--	VIe-M	98	Mountain Loam (Oak)	106	2141
DFE	Deer Creek-Mower complex, 25 to 50 percent slopes-----	36	-----	--	VIe-M	98	-----	---	2141
	Deer Creek soil-----	--	-----	--	-----	---	Mountain Loam (Oak)	106	
	Mower soil-----	--	-----	--	-----	---	Mountain Shallow Loam	107	
DgC	Denmark gravelly loam, 2 to 5 percent slopes-----	37	-----	--	VIIIs-S	100	Semi-desert Shallow Loam	109	4343
DhD	Donnardo cobbly loam, 4 to 16 percent slopes-----	38	-----	--	VIIs-U	99	Upland Stony Loam	111	3242
DKD	Donnardo very stony loam, 4 to 16 percent slopes-----	38	-----	--	VIIIs-U	101	Upland Stony Loam (Juniper-Pinon)	112	3242
DLD	Donnardo bouldery loam, 4 to 16 percent slopes-----	38	-----	--	VIIIs-U	101	Upland Stony Loam	111	3242
DoB	Doyce loam, 2 to 4 percent slopes-----	39	IIe-2	95	IVe-UZ	97	Upland Loam	110	1141-I 3242
DoC	Doyce loam, 4 to 8 percent slopes-----	39	IIIe-2	95	IVe-UZ	97	Upland Loam	110	1141-I 3242
DrB	Doyce loam, wet, 2 to 4 percent slopes-----	39	IIe-2	95	-----	---	-----	---	1141-I
Ds	Dyreg silty clay-----	40	IIIw-2	96	-----	---	-----	---	1141-I

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Described on page	Irrigated		Nonirrigated		Range site		Wildlife suita- bility group
			Symbol	Page	Symbol	Page	Name	Page	
Dy	Dyrenge silty clay, strongly saline-----	40	-----	--	VIIw-28	100	Alkali Bottoms	104	4424
Ep	Ephraim silty clay loam-	41	IIIw-2	96	VIw-2	98	Semi-wet Meadows	110	2121-I
FN	Fluvaquents-----	41	-----	--	Vw-2	97	Wet Meadows	113	2121
FOD	Fontneen cobbly loam, 4 to 20 percent slopes--	43	-----	--	VIIs-U	99	Upland Stony Loam (Juniper-Pinon)	112	3212
FRE2	Fontneen very cobbly loam, 20 to 40 percent slopes, eroded-----	43	-----	--	VIIIs-U	101	Upland Stony Loam (Juniper-Pinon)	112	3242
FRG2	Fontneen very cobbly loam, 40 to 70 percent slopes, eroded-----	43	-----	--	VIIIs-U	101	Upland Stony Loam (Juniper-Pinon)	112	3242
FSD2	Fontneen-Borvant com- plex, 4 to 25 percent slopes, eroded-----	43	-----	--	VIIs-U	99	-----	---	3242
	Fontneen soil-----	--	-----	--	-----	---	Upland Stony Loam (Juniper-Pinon)	112	
	Borvant soil-----	--	-----	--	-----	---	Upland Shallow Hardpan (Juniper-Pinon)	111	
FTD	Freedom-Amtoft complex, 2 to 30 percent slopes-----	44	-----	--	VIe-S	98	-----	---	
	Freedom soil-----	--	-----	--	-----	---	Semi-desert Loam	109	1141-I
	Amtoft soil-----	--	-----	--	-----	---	Semi-desert Shallow Loam	109	3342
GeB	Genola loam, 0 to 2 percent slopes-----	46	IIe-2	95	VIIe-S	99	Semi-desert Loam	109	4343
GeC2	Genola loam, 2 to 5 per- cent slopes, eroded---	46	IIIe-2	95	VIIe-S	99	Semi-desert Loam	109	1141-I
GeD2	Genola loam, 5 to 10 percent slopes, eroded-----	46	IVe-2	97	VIIe-S	99	Semi-desert Loam	109	3342
GkB	Genola loam, alkali, 0 to 2 percent slopes---	46	-----	--	VIIIs-S8	100	Semi-desert Alkali Flats	108	1141-I
GOF2	Gothic stony loam, 25 to 40 percent slopes, eroded-----	47	-----	--	VIe-H	98	High Mountain Loam	104	3141
Gr	Green River loam-----	48	IIIw-2	96	VIw-2	98	Semi-wet Meadows	110	2121-I
Gu	Gullied land-----	48	-----	--	VIIIe-E	101	-----	---	2121
Ha	Harding silt loam-----	49	-----	--	VIIIs-S8	100	Semi-desert Alkali Flats	108	4434
HED	Harkers silt loam, 6 to 25 percent slopes-----	49	-----	--	VIe-M	98	Mountain Loam (Oak)	106	2141
HKE	Harkers stony silt loam, 25 to 40 percent slopes-----	49	-----	--	VIe-M	98	Mountain Loam (Oak)	106	2141

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Described on page	Irrigated		Nonirrigated		Range site		Wildlife suita- bility group
			Symbol	Page	Symbol	Page	Name	Page	
KcB	Keigley silty clay loam, 2 to 4 percent slopes-	50	IIe-2	95	IVe-UZ	97	Upland Loam	110	1141-I 3242
KEG	Kitchell gravelly loam, 40 to 70 percent slopes-----	51	-----	--	VIIIs-HC	100	-----	---	3141
KM	Kitchell-Mower associa- tion----- Kitchell soil----- Mower soil-----	51 -- --	----- ----- -----	-- -- --	VIIIs-HC VIs-M	100 99	----- Mountain Stony Loam	--- 107	3141 2141
Kp	Kjar peaty silt loam----	52	-----	--	VIIw-28	100	Salt Meadows	107	4424
LdB	Linoyer very fine sandy loam, 1 to 2 percent slopes-----	53	IIe-2	95	VIIe-S	99	Semi-desert Loam	109	1141-I 3342
LdG2	Linoyer very fine sandy loam, 2 to 5 percent slopes, eroded-----	53	IIIe-2	95	VIIe-S	99	Semi-desert Loam	109	1141-I 3342
LeB	Lisade loam, 1 to 2 per- cent slopes-----	54	IIe-2	95	VIIe-S	99	Semi-desert Limy Loam	108	1141-I 3342
LeC2	Lisade loam, 2 to 5 per- cent slopes, eroded---	54	IIIe-2	95	VIIe-S	99	Semi-desert Limy Loam	108	1141-I 3342
LFC2	Lisade-Sanpete complex, 2 to 5 percent slopes, eroded----- Lisade soil----- Sanpete soil-----	54 -- --	----- ----- -----	-- -- --	VIIe-S ----- -----	99 -- ---	----- Semi-desert Limy Loam Semi-desert Stony Loam	--- 108 109	3342
LGE	Lizzant very cobbly loam, 20 to 40 percent slopes -----	55	-----	--	VIs-M	99	Mountain Stony Loam	107	3342
LHD	Lizzant stony loam, 4 to 20 percent slopes----	55	-----	--	VIs-M	99	Mountain Stony Loam	107	3242
LKG	Lizzant very stony loam, 40 to 60 percent slopes-----	55	-----	--	VIIIs-M	100	Mountain Stony Loam	107	3242
LLE	Lizzant-Clegg complex, 3 to 40 percent slopes-- Lizzant soil----- Clegg soil-----	55 -- --	----- ----- -----	-- -- --	VIs-M ----- -----	99 -- ---	Mountain Stony Loam Mountain Loam	107 106	3242 2141
LMF	Lizzant-Mower complex, 25 to 60 percent slopes-----	55	-----	--	VIIIs-M	100	Mountain Stony Loam	107	3242
LNE	Lizzant-Sedwell complex, 5 to 40 percent slopes----- Lizzant soil----- Sedwell soil-----	55 -- --	----- ----- -----	-- -- --	VIs-M ----- -----	99 --- ---	Mountain Stony Loam Mountain Loam (Oak)	107 106	3242 2141

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Described on page	Capability unit		Range site	Page	Wildlife suitability group
			Irrigated	Nonirrigated			
			Symbol	Page	Symbol	Page	Number
LOF	Lizzant-Kitchell association, steep----- Lizzant soil-----	56 --	-----	--	VIIIs-M	100	Mountain Stony Loam 107 3242
	Kitchell soil-----	--	-----	--	VIIIs-HC	100	----- 3141
LRE	Lodar very channery loam, 8 to 40 percent slopes-----	56	-----	--	VIIIs-U	101	Upland Shallow Loam (Juniper-Pinon) 112 3242
LSG	Lodar-Fontreen complex, 40 to 70 percent slopes----- Lodar soil-----	57 --	-----	--	VIIIs-U	101	----- 3242
	Fontreen soil-----	--	-----	--			Upland Shallow Loam (Juniper-Pinon) 112
							Upland Stony Loam (Juniper-Pinon) 112
LTE	Lodar-Rock outcrop complex, 8 to 40 percent slopes----- Lodar soil-----	57 --	-----	--	VIIIs-U	101	----- 3242
							Upland Shallow Loam (Juniper-Pinon) 112
	Rock outcrop-----	--	-----	--			----- 4444
LTG	Lodar-Rock outcrop complex, 40 to 70 percent slopes----- Lodar soil-----	57 --	-----	--	VIIIs-U	101	----- 3242
							Upland Shallow Loam (Juniper-Pinon) 112
	Rock outcrop-----	--	-----	--			----- 4444
LUE	Lundy channery silt loam, 5 to 40 percent slopes-----	57	-----	--	VIIs-M	99	Mountain Shallow Loam 107 3242
MA	Manassa-Mellor complex--	58	-----	--	VIIIs-S8	100	Semi-desert Alkali Flats 108 4434
MbC	Manila loam, 3 to 10 percent slopes-----	59	-----	--	IIIe-M	96	Mountain Loam (Oak) 106 2141
McB	Mayfield shaly loam, 2 to 5 percent slopes---	60	-----	--	VIIe-S	99	Semi-desert Loam 109 3342
McB2	Mayfield shaly loam, 2 to 5 percent slopes, eroded-----	60	-----	--	VIIe-S	99	Semi-desert Loam 109 3342
Md	Mellor silt loam-----	61	-----	--	VIIIs-S8	100	Semi-desert Alkali Flats 108 4434
Me	Mellor silt loam, leached surface-----	61	-----	--	VIe-S	98	Semi-desert Loam 109 3342
MfC	Moroni silty clay, 2 to 8 percent slopes-----	61	IIIe-25	96	IVe-U2	97	Upland Clay 111 1141-I
MGD	Moroni-Atepic complex, 2 to 30 percent slopes-- Moroni soil----- Atepic soil-----	61 -- --	-----	--	IVe-U2	97	----- 3242
							Upland Shallow Shale (Juniper-Pinon) 112 4343

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Described on page	Capability unit		Range site	Wildlife suita- bility group
			Irrigated	Nonirrigated		
			Symbol	Page	Name	Page
MHG	Mortenson silt loam, 40 to 70 percent slopes--	62	-----	---	VIIIs-HC 100	-----
MKG	Mortenson-Skylick asso- ciation, very steep--	62	-----	---	-----	---
	Mortenson soil-----	--	-----	---	VIIIs-HC 100	-----
	Skylick soil-----	--	-----	---	VIIe-H 99	High Mountain Loam 105 (Aspen)
MLD	Mortenson fine sandy loam, thin solum variant, 8 to 30 per- cent slopes-----	63	-----	---	VIIIs-HC 100	-----
MmC	Mountainville very stony sandy loam, 2 to 8 percent slopes-----	65	-----	---	VIIIs-U 101	Upland Stony Loam 111
MnC	Mountainville very stony loam, cool, 3 to 10 percent slopes-----	65	-----	---	VIIs-M 99	Mountain Stony Loam 107
MoC	Mountainville-Doyce com- plex, 2 to 8 percent slopes-----	65	-----	---	VIIIs-U 101	-----
	Mountain soil-----	--	-----	---	-----	Upland Stony Loam 111
	Doyce soil-----	--	-----	---	-----	Upland Loam 110
MrD	Mountainville cobbly fine fine sandy loam, hard- pan variant, 4 to 20 percent slopes-----	66	-----	---	VIIs-U 99	Upland Stony Loam 111
MSD	Mower clay loam, 5 to 30 percent slopes-----	67	-----	---	VIIs-M 99	Mountain Stony Loam 107
MTD	Mower stony clay loam, 5 to 30 percent slopes--	67	-----	---	VIIs-M 99	Mountain Stony Loam 107
MUF2	Mower very stony loam, 25 to 50 percent slopes, eroded-----	67	-----	---	VIIIs-M 100	Mountain Stony Loam 107
MVE	Mower-Lundy complex, 5 to 40 percent slopes--	67	-----	---	VIIs-M 99	-----
	Mower soil-----	--	-----	---	-----	Mountain Stony Loam 107
	Lundy soil-----	--	-----	---	-----	Mountain Shallow Loam 107
ObC	Obrast clay loam, low rainfall, 2 to 8 per- cent slopes-----	68	-----	---	IIIe-U 96	Upland Clay 111
OCD	Obrast silty clay, 4 to 25 percent slopes-----	68	-----	---	VIe-M 98	Mountain Clay 106
ODD	Obrast silty clay, shale substratum, 8 to 25 percent slopes-----	68	-----	---	VIe-M 98	Mountain Clay 106
PaC	Pavant loam, 4 to 8 per- cent slopes-----	69	-----	---	VIIIs-U 101	Upland Shallow Hardpan (Juniper-Pinon) 111

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Described on page	Capability unit		Range site	Wildlife suita- bility group
			Irrigated	Nonirrigated		
			Symbol	Page	Name	Page
PDC	Pavant-Doyce complex, 2 to 8 percent slopes----	70	-----	--	VIIs-U 99	-----
	Pavant soil-----	--	-----	--	-----	---
	Doyce soil-----	--	-----	--	-----	---
Pe	Peteetneet peat-----	70	-----	--	-----	---
Pg	Poganeab silt loam-----	71	-----	--	Vw-2 97	-----
Ph	Poganeab silt loam, strongly saline- alkali-----	71	-----	--	Vw-2 97	-----
Pl	Poganeab silt loam, high lime variant-----	72	-----	--	VIIw-28 100	-----
PRF	Pritchett stony fine sandy loam, 30 to 70 percent slopes-----	72	-----	--	Vw-2 97	-----
PTE	Pritchett silt loam, 20 to 40 percent slopes--	72	-----	--	VIIe-H 99	-----
QkE	Quaker silty clay loam, 1 to 2 percent slopes--	73	IIe-2 95	VIIe-S 99	High Mountain Loam (Aspen) Semi-desert Loam	104 109
QkC	Quaker silty clay loam, 2 to 5 percent slopes--	73	IIIe-2 95	VIe-S 98	Semi-desert Loam	109
Qm	Quaker and Mellor soils--	73	-----	--	VIIIs-S8 100	-----
RaC	Rapho gravelly fine sandy loam, 2 to 5 percent slopes-----	74	IIIe-2 95	VIIe-S 99	Semi-desert Loam	109
Rad	Rapho gravelly fine sandy loam, 5 to 10 percent slopes-----	74	IVe-2 97	VIIe-S 99	Semi-desert Loam	109
RLB	Ravola loam, 1 to 2 per- cent slopes-----	75	IIe-2 95	VIIe-S 99	Semi-desert Loam	109
RLC	Ravola loam, 2 to 5 per- cent slopes-----	75	IIIe-2 95	VIIe-S 99	Semi-desert Loam	109
RLC2	Ravola loam, 2 to 5 per- cent slopes, eroded---	75	-----	--	VIIe-S 99	-----
RO	Rock land-----	76	-----	--	VIIIs-X 101	-----
SaC	Sanpete gravelly fine sandy loam, 2 to 5 percent slopes-----	76	IVs-24 97	VIIIs-S 100	Semi-desert Stony Loam	109
SbD2	Sanpete cobbly fine sandy loam, 5 to 10 percent slopes, eroded-----	76	-----	--	VIIIs-S 100	-----
ScE2	Sanpete stony fine sandy loam, 5 to 30 percent slopes, eroded-----	77	-----	--	VIIIs-S 100	-----
SDE	Sanpitch very stony loam, 8 to 40 percent slopes--	77	-----	--	VIIs-U 99	-----
					Upland Stony Loam (Juniper-Pinon)	112

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Described on page	Capability unit		Range site		Wildlife suitability group		
			Irrigated	Nonirrigated	Name	Page			
SEE	Sanpitch-Obrast complex, 8 to 40 percent slopes-----	78	-----	----	VIIIs-U	101	-----	3242	
	Sanpitch soil-----	---	-----	----	-----	---	Upland Stony Loam (Juniper-Pinon)		112
	Obrast soil-----	---	-----	----	-----	---	Upland Clay		111
SFD	Sanpitch loam, red variant, 10 to 30 percent slopes-----	78	-----	----	VIIs-U	99	Upland Stony Loam (Juniper-Pinon)	112	3242
SH	Shaly colluvial land----	79	-----	----	VIIIs-S	100	Semi-desert Shallow Loam	109	4343
Sm	Shumway silty clay loam-----	80	-----	----	Vw-2	97	Wet Meadows	113	3212
Sn	Shumway silty clay loam, drained-----	80	IIIw-2	96	-----	---	-----	---	2121-I
SoD2	Sigurd cobbly fine sandy loam, 5 to 10 percent slopes, eroded-----	81	-----	----	VIIIs-S	100	Semi-desert Stony Loam	109	3242-I 4343
SpC	Sigurd gravelly loam, 1 to 5 percent slopes---	81	IVs-24	97	VIIIs-S	100	Semi-desert Stony Loam	109	3242-I 4343
SrB	Skumpah silt loam, 1 to 2 percent slopes-----	82	-----	----	VIIIs-S8	100	Semi-desert Alkali Flats	108	4434
SrC2	Skumpah silt loam, 2 to 5 percent slopes, eroded-----	82	-----	----	VIIIs-S8	100	Semi-desert Alkali Flats	108	4434
SSD	Skylick silt loam, 4 to 30 percent slopes-----	83	-----	----	VIe-H	98	High Mountain Loam (Aspen)	105	3141
SSF	Skylick silt loam, 30 to 70 percent slopes-----	83	-----	----	VIIe-H	99	High Mountain Loam (Aspen)	105	3141
StB	Snake Hollow gravelly fine sandy loam, 2 to 4 percent slopes-----	84	IIe-2	95	VIe-U	98	Upland Loam	110	1141-I 3242
TGG	Tingey-Rock outcrop complex, 40 to 70 percent slopes-----	85	-----	----	VIIIs-M	100	Mountain Loam (Oak)	106	3141
	Tingey soil-----	---	-----	----	-----	---	-----	---	4444
	Rock outcrop-----	---	-----	----	-----	---	-----	---	4444
TGH	Tingey-Rock outcrop complex, 70 to 80 percent slopes-----	85	-----	----	VIIIe-X	101	Mountain Loam (Oak)	106	3141
	Tingey soil-----	---	-----	----	-----	---	-----	---	4444
	Rock outcrop-----	---	-----	----	-----	---	-----	---	4444
ToB	Toehead silt loam, 2 to 4 percent slopes-----	86	IIIe-3	95	IIIe-U	96	Upland Loam	110	2141-I 2141
ToC	Toehead silt loam, 4 to 8 percent slopes-----	86	IIIe-3	95	IIIe-U	96	Upland Loam	110	2141-I 2141
TSD	Toehead silt loam, thin surface variant, 4 to 20 percent slopes-----	86	-----	----	IIIe-U	96	Upland Loam	110	2141

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	on page	Described		Irrigated		Nonirrigated		Range site		Wildlife suita- bility group
			Symbol	Page	Symbol	Page	Symbol	Page	Name	Page	
TT	Torrifluvents and Torriorthents, stony--	87	-----	--	VIIIs-S	100			Semi-desert Stony Loam	109	3342
TVD	Toze gravelly loam, 4 to 25 percent slopes-----	87	-----	--	VIe-H	98			High Mountain Loam	104	3141
WAC	Wales loam, 2 to 8 per- cent slopes-----	88	-----	--	IVe-UZ	97			Upland Loam	110	3242
WcA	Wales silty clay loam, low rainfall, 0 to 2 percent slopes-----	88	IIe-2	95	VIIe-S	99			Semi-desert Loam	109	1141-I 3342
WcB	Wales silty clay loam, low rainfall, 2 to 5 percent slopes-----	88	IIIe-2	95	VIIe-S	99			Semi-desert Loam	109	1141-I
WDE	Wallsburg very stony loam, 20 to 40 percent slopes-----	89	-----	--	VIIIs-M	100			Mountain Shallow Loam	107	3242
WEG	Wallsburg-Rock outcrop complex, 40 to 70 per- cent slopes-----	89	-----	--	VIIIs-M	100			Mountain Shallow Loam	107	3242
	Wallsburg soil-----	--	-----	--	-----	---			-----	---	4444
WGD	Rock outcrop-----	--	-----	--	-----	---			-----	---	4444
	Watkins Ridge stony loam, high rainfall, 4 to 25 percent slopes-----	90	-----	--	VIe-M	98			Mountain Loam	106	2141
WhB	Watkins Ridge silt loam, 1 to 6 percent slopes--	90	IIIe-3	95	IIIe-U	96			Upland Loam	110	2141-I 2141
WoA	Woodrow silty clay loam, 0 to 2 percent slopes--	91	IIe-2	95	VIIe-S	99			Semi-desert Loam	109	1141-I 3342
WoC2	Woodrow silty clay loam, 2 to 5 percent slopes, eroded-----	91	IIIe-2	95	VIIe-S	99			Semi-desert Loam	109	1141-I 3342
XE	Xerofluvents and Fluva- quents-----	91	-----	--	VIw-2	98			Semi-wet Meadows	110	2121
XF	Xerofluvents and Fluvaquents, saline---	91	-----	--	VIIw-28	100			Alkali Bottoms	104	4424
YHE	Yeates Hollow stony silt loam, 20 to 40 percent slopes-----	92	-----	--	VIIs-M	99			Mountain Stony Loam	107	3242
ZSE	Zeesix stony silt loam, 8 to 40 percent slopes-----	93	-----	--	VIe-H	98			High Mountain Loam	104	3141
ZTE	Zeesix-Toze complex, 4 to 40 percent slopes--	93	-----	--	VIe-H	98			High Mountain Loam	104	3141

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MAP UNITS*

DOMINANTLY WELL DRAINED AND SOMEWHAT EXCESSIVELY DRAINED. NEARLY LEVEL TO STEEP. DEEP SOILS ON FLOOD PLAINS, ALLUVIAL FANS, AND VALLEY BOTTOMS

1 Genola Woodrow Quaker association. Well drained, nearly level to strongly sloping, deep silty clay loams, clay loams, and loams on flood plains, alluvial plains, and alluvial fans in the valleys

2 Arapien Sanpete Lisade association. Somewhat excessively drained to moderately well drained, gently sloping to strongly sloping, deep clay loams, loams, very gravelly sandy loams, gravelly sandy loams, and sandy loams on the higher alluvial fans and alluvial plains

3 Sanpete Sigurd association. Somewhat excessively drained, moderately sloping to steep, deep gravelly sandy loams and very gravelly sandy loams on highest alluvial fans, flood plains, or alluvial plains in the valleys

4 Birdow Keigley Doyce association. Well drained and moderately well drained, gently sloping to strongly sloping, deep very fine sandy loams, silty clay loams, and sandy clay loams on alluvial fans, flood plains, and alluvial plains

5 Manila Ant Flat Deer Creek association. Well drained, moderately sloping to steep, deep silty clays and clays on alluvial fans, alluvial plains, and lower mountain slopes

DOMINANTLY WELL DRAINED AND SOMEWHAT EXCESSIVELY DRAINED. GENTLY SLOPING TO VERY STEEP. SHALLOW AND DEEP SOILS AND ROCK LAND ON THE HIGHER ALLUVIAL FANS, FOOTHILLS, UPLAND PLATEAUS, AND LOWER MOUNTAIN SLOPES

6 Fontreen Lodar Borvant association. Somewhat excessively drained, moderately sloping to very steep, deep and shallow very gravelly loams on ridges, lower mountain slopes, alluvial fans, and foothills

7 Amloft Sanpete Rock land association. Somewhat excessively drained, gently sloping to very steep, shallow and deep flaggy loams and very gravelly sandy loams and Rock land on alluvial fans and foothills

8 Rock land Atepic Amloft association. Rock land and well drained and somewhat excessively drained, strongly sloping to very steep, shallow flaggy loams and shaly silty clay loams on upland plateaus

9 Borvant Mountainville Doyce association. Somewhat excessively drained to moderately well drained, gently sloping to steep, deep and shallow very gravelly loams, very stony sandy clay loams, and sandy clay loams on alluvial fans and foothills

DOMINANTLY WELL DRAINED. GENTLY SLOPING TO MODERATELY SLOPING. DEEP, SALINE SOILS ON ALLUVIAL FANS, ALLUVIAL PLAINS, VALLEY BOTTOMS, AND BADLAND

10 Badland Skumpah association. Badland and well drained, gently sloping to moderately sloping, deep silty clay loams on alluvial fans, alluvial plains, and valley bottoms

DOMINANTLY POORLY DRAINED, NEARLY LEVEL TO MODERATELY SLOPING. DEEP SOILS ON FLOOD PLAINS, LAKE TERRACES, AND ALLUVIAL FANS

11 Xerofluvents and Fluvaquent Mellor association. Well drained to poorly drained, nearly level to moderately sloping, deep, nonsaline to strongly saline, stratified loamy sands to clays on the flood plains, lake terraces, and alluvial fans

12 Poganeab Shumway Chipman association. Poorly drained, nearly level to gently sloping, deep silty clay loams and silty clays on flood plains and alluvial fans in the valley bottoms

DOMINANTLY WELL DRAINED AND SOMEWHAT EXCESSIVELY DRAINED. MODERATELY SLOPING TO VERY STEEP. SHALLOW TO DEEP SOILS ON MOUNTAINS, AND ROCK LAND

13 Lizzant Mower Lundy association. Well drained and somewhat excessively drained, moderately sloping to very steep, deep to shallow cobbly loams, silty clay loams, and very flaggy clay loams on broad ridges and mountains

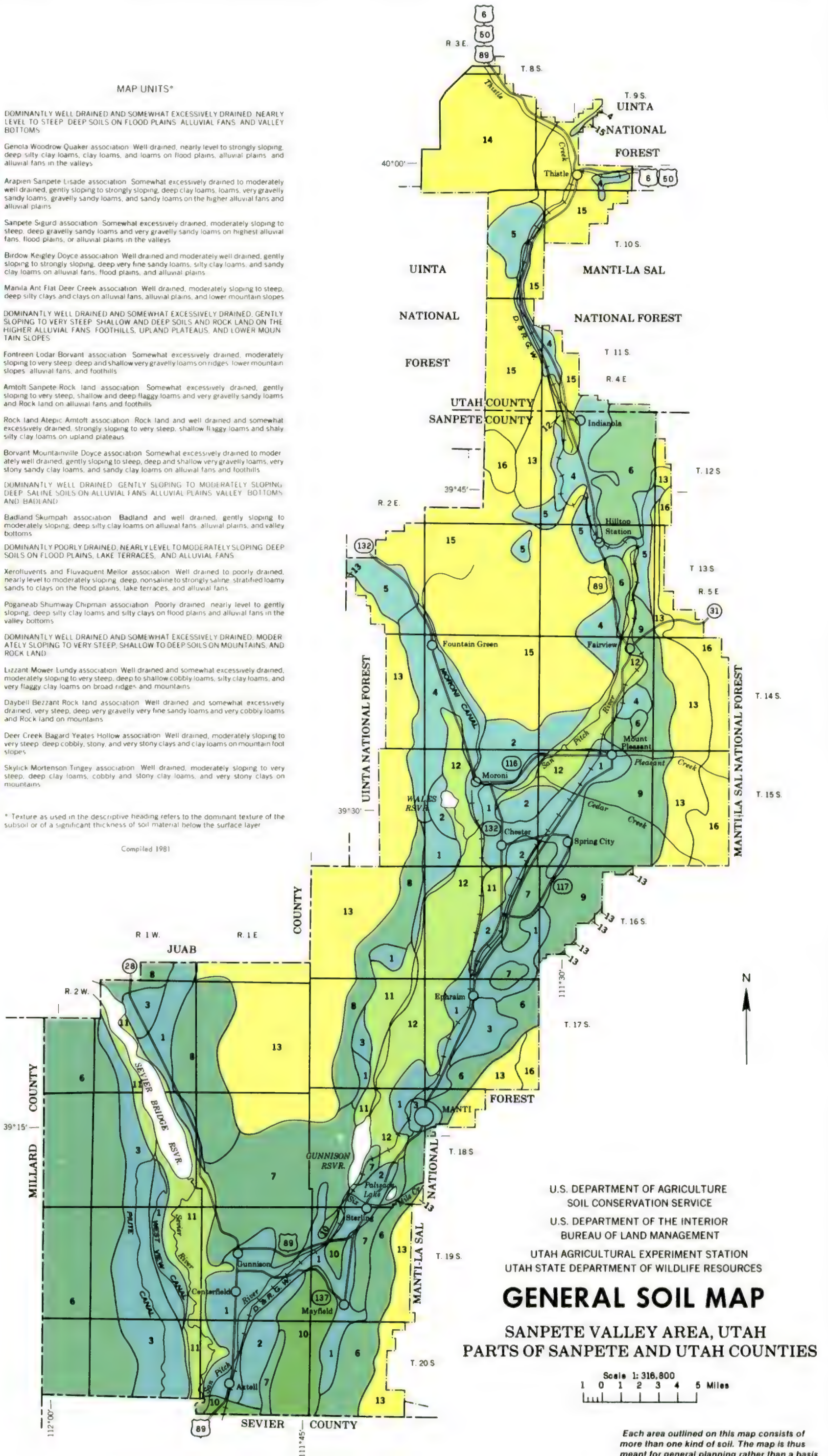
14 Daybell Bezzant Rock land association. Well drained and somewhat excessively drained, very steep, deep very gravelly very fine sandy loams and very cobbly loams and Rock land on mountains

15 Deer Creek Bagard Yeates Hollow association. Well drained, moderately sloping to very steep, deep cobbly, stony, and very stony clays and clay loams on mountain foot slopes

16 Skylick Mortenson Tingey association. Well drained, moderately sloping to very steep, deep clay loams, cobbly and stony clay loams, and very stony clays on mountains

* Texture as used in the descriptive heading refers to the dominant texture of the subsoil or of a significant thickness of soil material below the surface layer

Compiled 1981



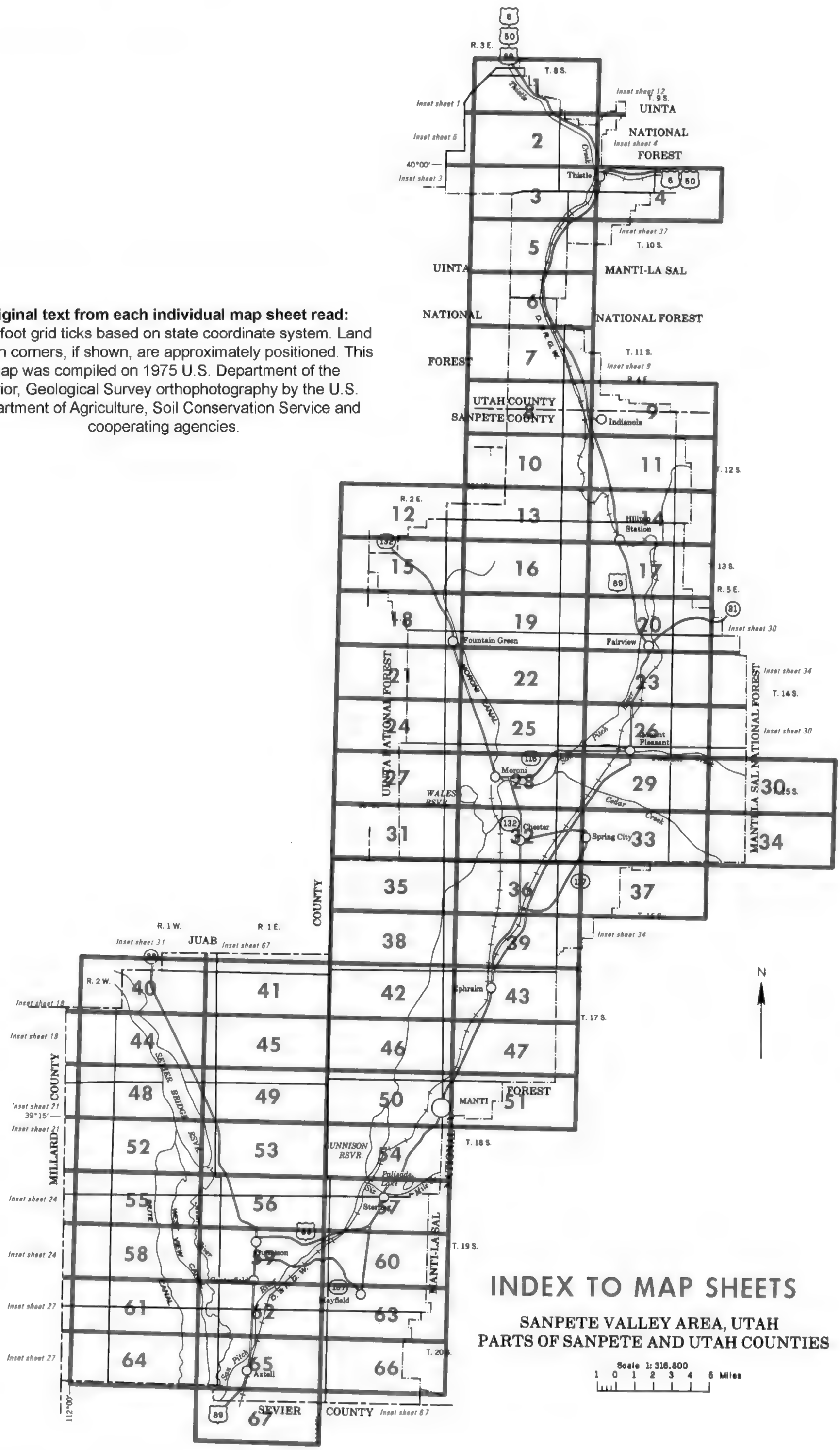
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UTAH STATE DEPARTMENT OF WILDLIFE RESOURCES

GENERAL SOIL MAP SANPETE VALLEY AREA, UTAH PARTS OF SANPETE AND UTAH COUNTIES

Scale 1:316,800
1 0 1 2 3 4 5 Miles

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

Original text from each individual map sheet read:
 5,000-foot grid ticks based on state coordinate system. Land division corners, if shown, are approximately positioned. This map was compiled on 1975 U.S. Department of the Interior, Geological Survey orthophotography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.



INDEX TO MAP SHEETS **SANPETE VALLEY AREA, UTAH** **PARTS OF SANPETE AND UTAH COUNTIES**

Scale 1:316,800
 1 0 1 2 3 4 5 Miles

SOIL LEGEND

The first letter, always a capital, is the initial one of the map unit. The second letter is a capital if the map unit is one of the low intensity survey; otherwise, it is a small letter. The third letter, always a capital, A, B, C, D, E, F, G, or H, shows the slope. Most symbols without a slope letter are those of nearly level slopes, but some are for land types that have a considerable range of slope. A final number, 2, in the symbol shows that the soil is eroded.

SYMBOL		NAME
High Intensity	Low Intensity	
Aa	-	Abcal silty clay loam
Ab	-	Abcal silty clay loam, strongly saline
Ac	-	Abcal-Cache complex
-	ADG	Adel silt loam, 40 to 80 percent slopes
-	AEE	Amtoft flaggy loam, 8 to 30 percent slopes
-	AFG2	Amtoft-Rock outcrop complex, 30 to 60 percent slopes, eroded
Ag	-	Anco silty clay loam
-	AHD	Ant Flat stony loam, 8 to 25 percent slopes
-	AHE2	Ant Flat stony loam, 25 to 40 percent slopes, eroded
AkC	-	Ant Flat loam, low rainfall, 4 to 8 percent slopes
-	ALD	Ant Flat-Borvant complex, 4 to 25 percent slopes
AmB	-	Arapien fine sandy loam, 1 to 2 percent slopes
AmC2	-	Arapien fine sandy loam, 2 to 5 percent slopes, eroded
AmD2	-	Arapien fine sandy loam, 5 to 10 percent slopes, eroded
AnB	-	Arapien fine sandy loam, saline-alkali, 1 to 2 percent slopes
ApB	-	Arapien fine sandy loam, wet, 1 to 2 percent slopes
ApC2	-	Arapien clay loam, gravelly subsoil, 2 to 5 percent slopes, eroded
-	ARD	Arapien-Calita complex, 2 to 15 percent slopes
-	ASE2	Atepic shaly loam, 10 to 30 percent slopes, eroded
-	ATF	Atepic very cobbly silty clay loam, 8 to 40 percent slopes
-	AUF	Atepic clay loam, red variant-Rock outcrop complex, 30 to 50 percent slopes
-	AV	Atepic-Badland association
-	BA	Badland
-	BCE	Bagard very stony clay loam, 10 to 40 percent slopes
-	BDE	Bagard-Sanpitch complex, 8 to 40 percent slopes
Be	-	Beek silty clay loam
-	BEF	Bezzant cobbly loam, 4 to 25 percent slopes
-	BGE	Bezzant stony loam, 25 to 40 percent slopes
-	BH	Bezzant-Gappmayer-Rock land association, very steep
Bm	-	Billings silty clay loam
BnB	-	Birdow very fine sandy loam, 2 to 4 percent slopes
BnC	-	Birdow very fine sandy loam, 4 to 8 percent slopes
BoB	-	Birdow silt loam, 2 to 4 percent slopes
-	BRD2	Borvant cobbly loam, 8 to 25 percent slopes, eroded
-	BSE2	Borvant-Bagard complex, 10 to 40 percent slopes, eroded
-	BTC	Borvant-Doyce complex, 2 to 10 percent slopes
-	BUD2	Borvant-Lodar complex, 8 to 25 percent slopes, eroded
-	BVG	Bradshaw very stony loam, 60 to 80 percent slopes
CaB	-	Calita loam, 2 to 4 percent slopes
CaC	-	Calita loam, 4 to 8 percent slopes
Cb	-	Canburn silty clay loam
CcB	-	Centerfield silty clay loam, 1 to 2 percent slopes
CcC2	-	Centerfield silty clay loam, 2 to 5 percent slopes, eroded
-	CDG	Cheadle very flaggy silt loam, 40 to 70 percent slopes
Ch	-	Chipman silty clay loam
Cm	-	Chipman complex
-	CNC	Clegg loam, 3 to 10 percent slopes
CoC	-	Collard gravelly sandy loam, 4 to 8 percent slopes
-	CRD	Collard stony sandy loam, 4 to 20 percent slopes
CsC	-	Crestline fine sandy loam, 2 to 5 percent slopes
-	CU	Cryoborolls
-	DAG	Daybell gravelly silt loam, 40 to 70 percent slopes
-	DBG	Daybell-Flygare association, very steep
-	DCD	Deer Creek stony silt loam, 6 to 30 percent slopes
-	DED	Deer Creek stony silt loam, high rainfall, 6 to 25 percent slopes
-	DEE	Deer Creek stony silt loam, high rainfall, 25 to 40 percent slopes
-	DFE	Deer Creek-Mower complex, 25 to 50 percent slopes
DgC	-	Denmark gravelly loam, 2 to 5 percent slopes
DnD	-	Donnardo cobbly loam, 4 to 16 percent slopes
-	DKD	Donnardo very stony loam, 4 to 16 percent slopes
-	DLD	Donnardo bouldery loam, 4 to 16 percent slopes
DoB	-	Doyce loam, 2 to 4 percent slopes
DoC	-	Doyce loam, 4 to 8 percent slopes
DrB	-	Doyce loam, wet, 2 to 4 percent slopes
Ds	-	Dyreg silty clay
Dy	-	Dyreg silty clay, strongly saline
Ep	-	Ephraim silty clay loam
-	FN	Fluvaquents
-	FOD	Fontreen cobbly loam, 4 to 20 percent slopes
-	FRE2	Fontreen very cobbly loam, 20 to 40 percent slopes, eroded
-	FRG2	Fontreen very cobbly loam, 40 to 70 percent slopes, eroded
-	FSD2	Fontreen-Borvant complex, 4 to 25 percent slopes, eroded
-	FTD	Freedom-Amtoft complex, 2 to 30 percent slopes

SYMBOL		NAME
High Intensity	Low Intensity	
GeB	-	Genola loam, 0 to 2 percent slopes
GeC2	-	Genola loam, 2 to 5 percent slopes, eroded
GeD2	-	Genola loam, 5 to 10 percent slopes, eroded
GhB	-	Genola loam, 0 to 2 percent slopes
-	GOF2	Gothic stony loam, 25 to 40 percent slopes, eroded
Gr	-	Green River loam
Gu	-	Gullied land
Ha	-	Harding silt loam
-	HED	Harkers silt loam, 6 to 25 percent slopes
-	HKE	Harkers stony silt loam, 25 to 40 percent slopes
KcB	-	Keigley silty clay loam, 2 to 4 percent slopes
-	KEG	Kitchell gravelly loam, 40 to 70 percent slopes
-	KM	Kitchell-Mower association
Kp	-	Kjar peaty silt loam
LdB	-	Lindsey very fine sandy loam, 1 to 2 percent slopes
LdC2	-	Lindsey very fine sandy loam, 2 to 5 percent slopes, eroded
LdB	-	Lisade loam, 1 to 2 percent slopes
LeB	-	Lisade loam, 2 to 5 percent slopes, eroded
LeC2	-	Lisade-Sanpitch complex, 2 to 5 percent slopes, eroded
-	LFC2	Lizzant very cobbly loam, 20 to 40 percent slopes
-	LGE	Lizzant stony loam, 4 to 20 percent slopes
-	LHD	Lizzant very stony loam, 40 to 60 percent slopes
-	LKG	Lizzant-Clegg complex, 3 to 40 percent slopes
-	LLE	Lizzant-Mower complex, 25 to 60 percent slopes
-	LMF	Lizzant-Sedwell complex, 5 to 40 percent slopes
-	LNE	Lizzant-Kitchell association, steep
-	LOF	Lodar very channery loam, 8 to 40 percent slopes
-	LRE	Lodar-Fortreen complex, 40 to 70 percent slopes
-	LSG	Lodar-Rock outcrop complex, 8 to 40 percent slopes
-	LTE	Lodar-Rock outcrop complex, 40 to 70 percent slopes
-	LTG	Lundy channery silt loam, 5 to 40 percent slopes
-	LUE	
-	MA	Manassa-Mellor complex
-	MbC	Manila loam, 3 to 10 percent slopes
-	McB	Mayfield shaly loam, 2 to 5 percent slopes
-	McB2	Mayfield shaly loam, 2 to 5 percent slopes, eroded
-	Md	Mellor silt loam
-	Me	Mellor silt loam, leached surface
-	MHC	Moroni silty clay, 2 to 8 percent slopes
-	MGD	Moroni-Atepic complex, 2 to 30 percent slopes
-	MHG	Mortenson silt loam, 40 to 70 percent slopes
-	MKG	Mortenson-Skytick association, very steep
-	MLD	Mortenson fine sandy loam, thin solum variant, 8 to 30 percent slopes
-	MmC	Mountainville very stony sandy loam, 2 to 8 percent slopes
-	MnC	Mountainville very stony loam, cool, 3 to 10 percent slopes
-	MoC	Mountainville-Doyce complex, 2 to 8 percent slopes
-	MdD	Mountainville cobbly fine sandy loam, hardpan variant, 4 to 20 percent slopes
-	MSD	Mower clay loam, 5 to 30 percent slopes
-	MTD	Mower stony clay loam, 5 to 30 percent slopes
-	MUF2	Mower very stony loam, 25 to 50 percent slopes, eroded
-	MVE	Mower-Lundy complex, 5 to 40 percent slopes

ObC	-	Obrast clay loam, low rainfall, 2 to 8 percent slopes
-	ODC	Obrast silty clay, 4 to 25 percent slopes
-	ODD	Obrast silty clay, shale substratum, 8 to 25 percent slopes
PaC	-	Pavant loam, 4 to 8 percent slopes
-	PDC	Pavant-Doyce complex, 2 to 8 percent slopes
Pe	-	Peteetneet peat
Pg	-	Poganeab silt loam
Ph	-	Poganeab silt loam, strongly saline-alkali
Pr	-	Poganeab silt loam, high lime variant
-	PRF	Pritchett stony fine sandy loam, 30 to 70 percent slopes
-	PTE	Pritchett silt loam, 20 to 40 percent slopes
QkB	-	Quaker silty clay loam, 1 to 2 percent slopes
QhC	-	Quaker silty clay loam, 2 to 5 percent slopes
Qm	-	Quaker and Mellor soils

RaC	-	Rapho gravelly fine sandy loam, 2 to 5 percent slopes
RaD	-	Rapho gravelly fine sandy loam, 5 to 10 percent slopes
RIB	-	Ravola loam, 1 to 2 percent slopes
RIC	-	Ravola loam, 2 to 5 percent slopes
RIC2	-	Ravola loam, 2 to 5 percent slopes, eroded
-	RO	Rockland

SYMBOL		NAME
High Intensity	Low Intensity	
SaC	-	Sanpete gravelly fine sandy loam, 2 to 5 percent slopes
Sbd2	-	Sanpete cobbly fine sandy loam, 5 to 10 percent slopes, eroded
-	SCE2	Sanpete stony fine sandy loam, 5 to 30 percent slopes, eroded
-	SDE	Sanpitch very stony loam, 8 to 40 percent slopes
-	SEE	Sanpitch-Obrast complex, 8 to 40 percent slopes
-	SFD	Sanpitch loam, red variant, 10 to 30 percent slopes
-	SH	Shaly colluvial land
Sm	-	Shumway silty clay loam
Sn	-	Shumway silty clay loam, drained
SoD2	-	Sigurd cobbly fine sandy loam, 5 to 10 percent slopes, eroded
SpC	-	Sigurd gravelly loam, 1 to 5 percent slopes
SrB	-	Skumpah silt loam, 1 to 2 percent slopes
SrC2	-	Skumpah silt loam, 2 to 5 percent slopes, eroded
-	SSD	Skytick silt loam, 4 to 30 percent slopes
-	SSF	Skytick silt loam, 30 to 70 percent slopes
SIB	-	Snake Hollow gravelly fine sandy loam, 2 to 4 percent slopes
-	TGG	Tingey-Rock outcrop complex, 40 to 70 percent slopes
-	TGH	Tingey-Rock outcrop complex, 70 to 80 percent slopes
ToB	-	Toehead silt loam, 2 to 4 percent slopes
ToC	-	Toehead silt loam, 4 to 8 percent slopes
-	TSB	Toehead silt loam, thin surface variant, 4 to 20 percent slopes
-	TT	Torrifluents and Torriorthents, stony
-	TVB	Toze gravelly loam, 4 to 25 percent slopes
-	WAC	Wales loam, 2 to 8 percent slopes
-	WcA	Wales silty clay loam, low rainfall, 0 to 2 percent slopes
-	WcB	Wales silty clay loam, low rainfall, 2 to 5 percent slopes
-	WDE	Wallsburg very stony loam, 20 to 40 percent slopes
-	WEG	Wallsburg-Rock outcrop complex, 40 to 70 percent slopes
-	WGD	Watkins Ridge stony loam, high rainfall, 4 to 25 percent slopes
-	WhB	Watkins Ridge silt loam, 1 to 6 percent slopes
-	WoA	Woodrow silty clay loam, 0 to 2 percent slopes
-	WoC2	Woodrow silty clay loam, 2 to 5 percent slopes, eroded
-	XE	Xerofluents and Fluvaquents
-	XF	Xerofluents and Fluvaquents, saline
-	YHE	Yeates Hollow stony silt loam, 20 to 40 percent slopes
-	ZSE	Zeesux stony silt loam, 8 to 40 percent slopes
-	ZTE	Zeesux-Toze complex, 4 to 40 percent slopes

CULTURAL FEATURES

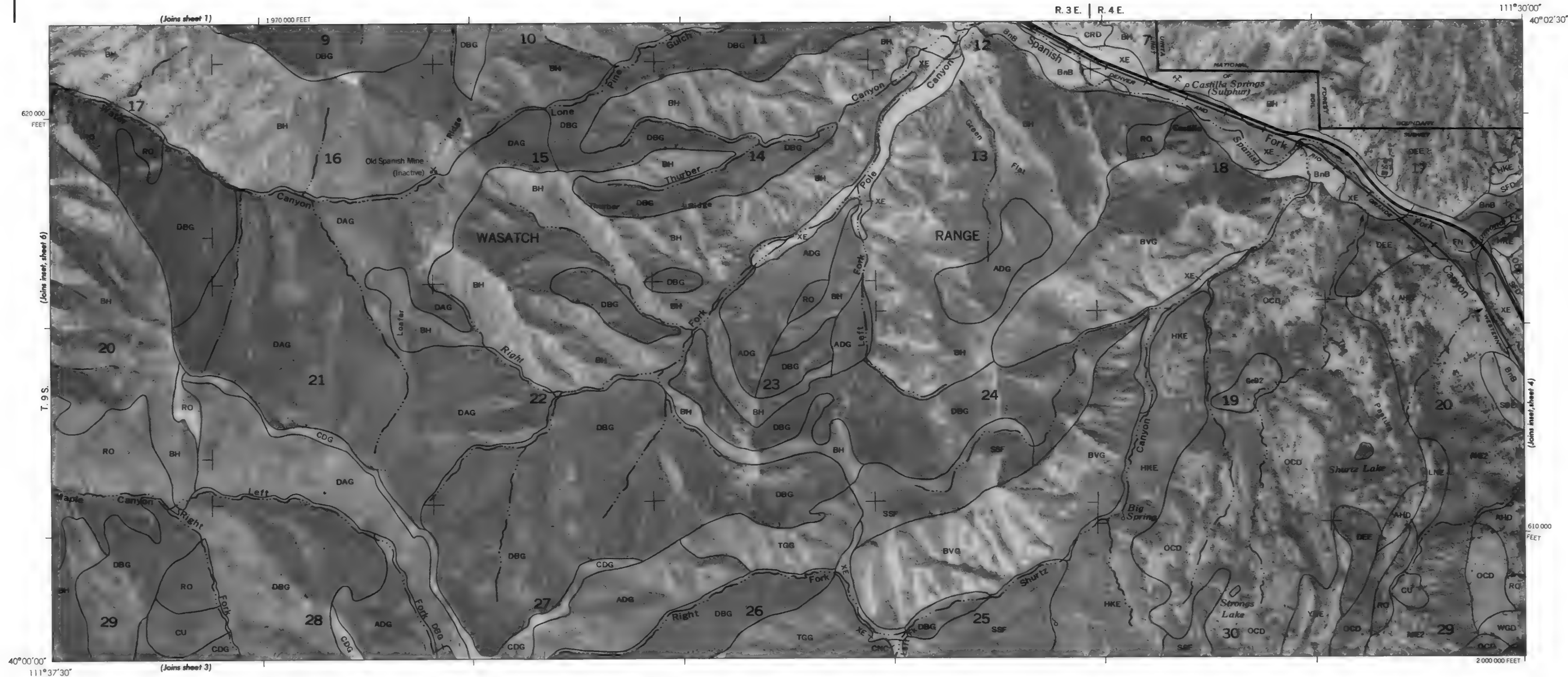
BOUNDARIES	
National, state or province	-----
County or parish	-----
Minor civil division	-----
Reservation (national forest or park, state forest or park, and large airport)	-----
Land grant	-----
Limit of soil survey (label)	-----
Field sheet matchline & neatline	-----
AD HOC BOUNDARY (label)	-----
Small airport, airfield, park, oilfield, cemetery, or flood pool	-----
STATE COORDINATE TICK	-----
LAND DIVISION CORNERS (sections and land grants)	-----
ROADS	-----
Divided (median shown if scale permits)	-----
Other roads	-----
Trail	-----
ROAD EMBLEMS & DESIGNATIONS	-----
Interstate	-----
Federal	-----
State	-----
County, farm or ranch	-----
RAILROAD	-----
POWER TRANSMISSION LINE (normally not shown)	-----
PIPE LINE (normally not shown)	-----
FENCE (normally not shown)	-----
LEVEES	-----
Without road	-----
With road	-----
With railroad	-----
DAMS	-----
Large (to scale)	-----
Medium or small	-----

PITS	
Gravel pit	-----
Mine or quarry	-----
MISCELLANEOUS CULTURAL FEATURES	-----
Farmstead, house (omit in urban areas)	-----
Church	-----
School	-----
Indian mound (label)	-----
Located object (label)	-----
Tank (label)	-----
Wells, oil or gas	-----
Windmill	-----
Kitchen midden	-----
DRAINAGE	-----
Perennial, double line	-----
Perennial, single line	-----
Intermittent	-----
Drainage end	-----
Canals or ditches	-----
Double-line (label)	-----
Drainage and/or irrigation	-----
LAKES, PONDS AND RESERVOIRS	-----
Perennial	-----
Intermittent	-----
MISCELLANEOUS WATER FEATURES	-----
Marsh or swamp	-----
Spring	-----
Well, artesian	-----
Well, irrigation	-----
Wet spot	-----

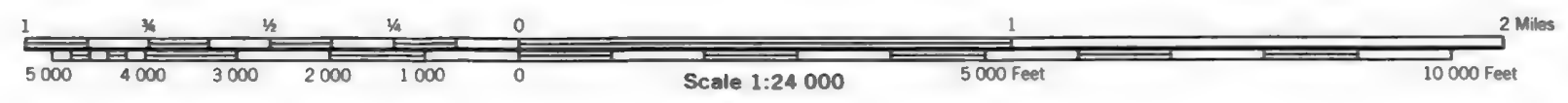
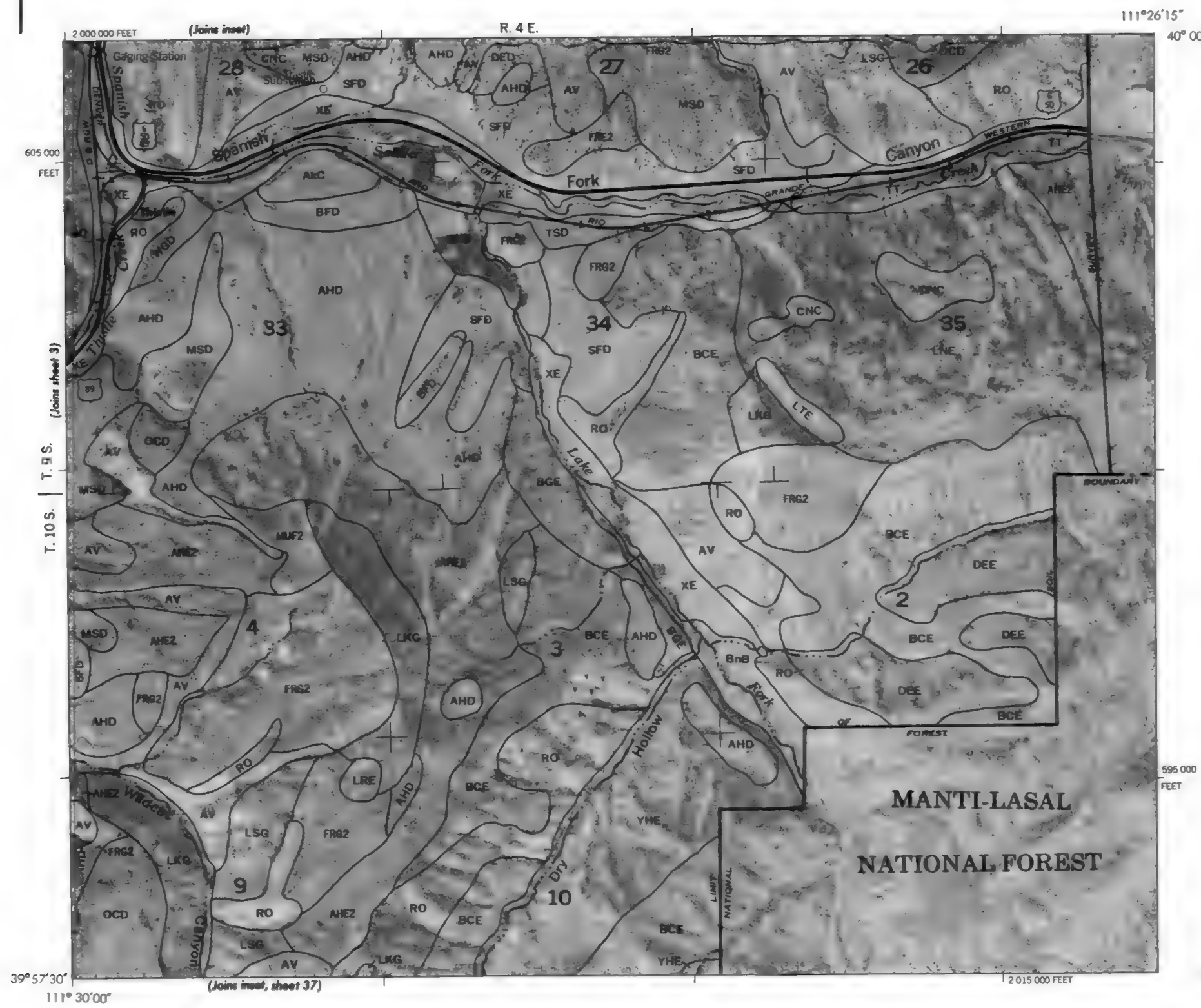
SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS	
ESCARPMENTS	-----
Bedrock (points down slope)	-----
Other than bedrock (points down slope)	-----
SHORT STEEP SLOPE	-----
GULLY	-----
DEPRESSION OR SINK	-----
SOIL SAMPLE SITE (normally not shown)	-----
MISCELLANEOUS	-----
Blowout	-----
Clay spot	-----
Gravelly spot	-----
Gumbo, slick or scabby spot (sodic)	-----
Dumps and other similar non soil areas	-----
Prominent hill or peak	-----
Rock outcrop (includes sandstone and shale)	-----
Saline spot	-----
Sandy spot	-----
Severely eroded spot	-----
Slide or slip (tips point upslope)	-----
Stony spot, very stony spot	-----
Strongly saline - alkali, less than 1 acre	-----

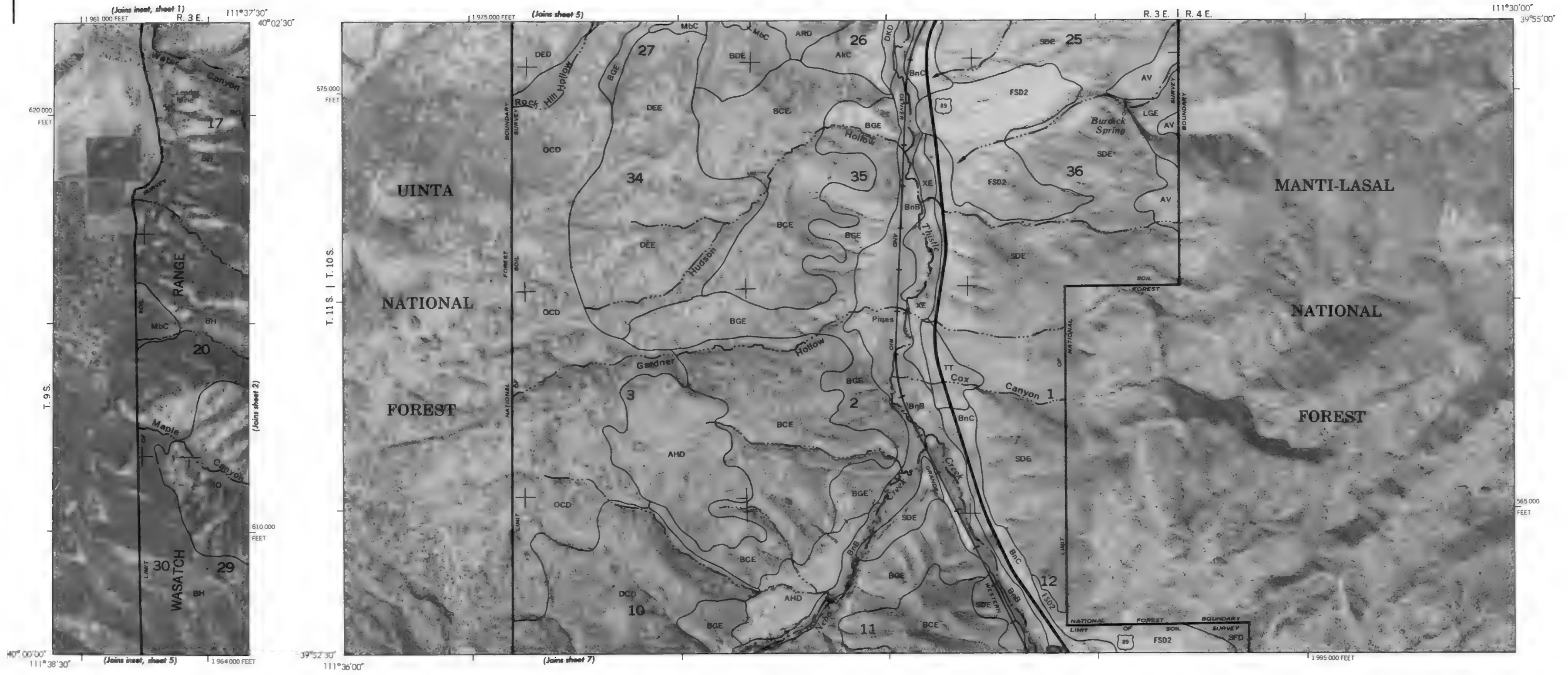






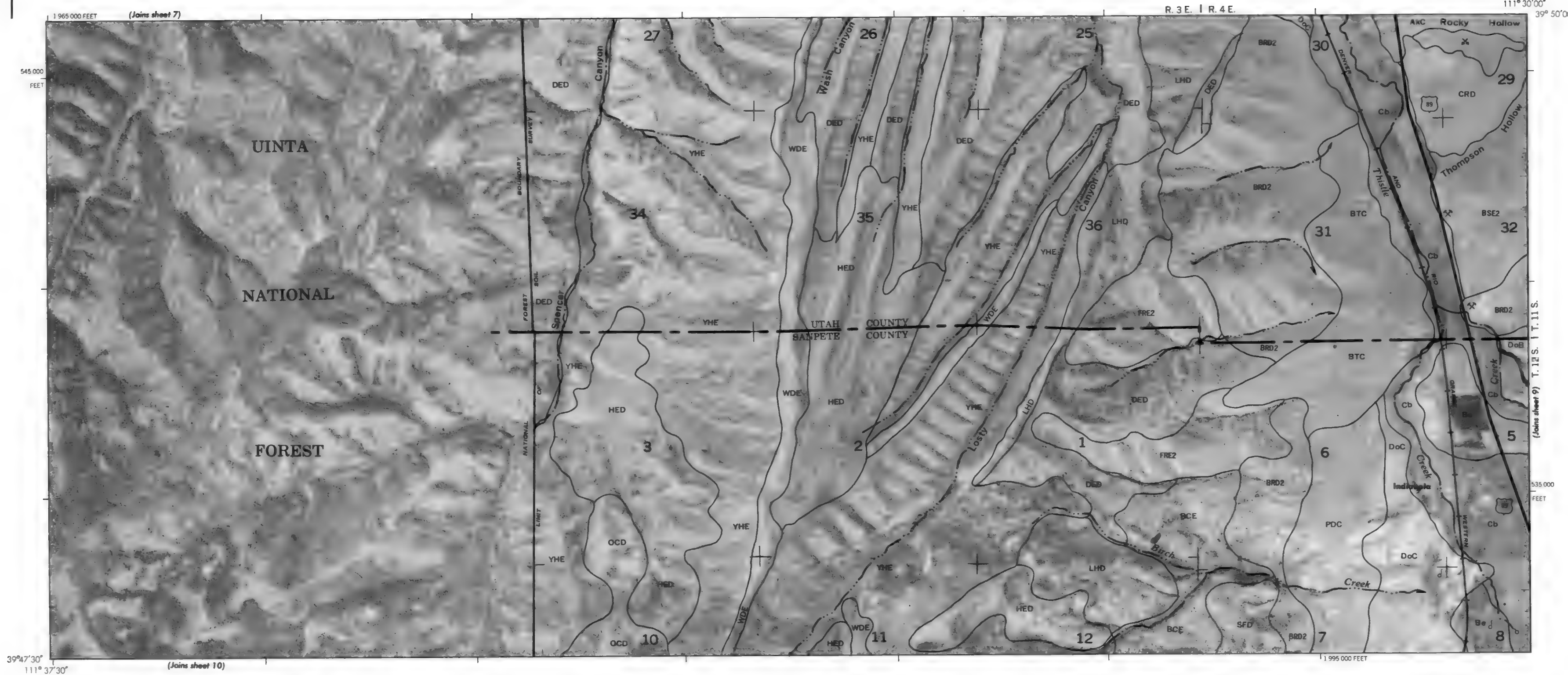


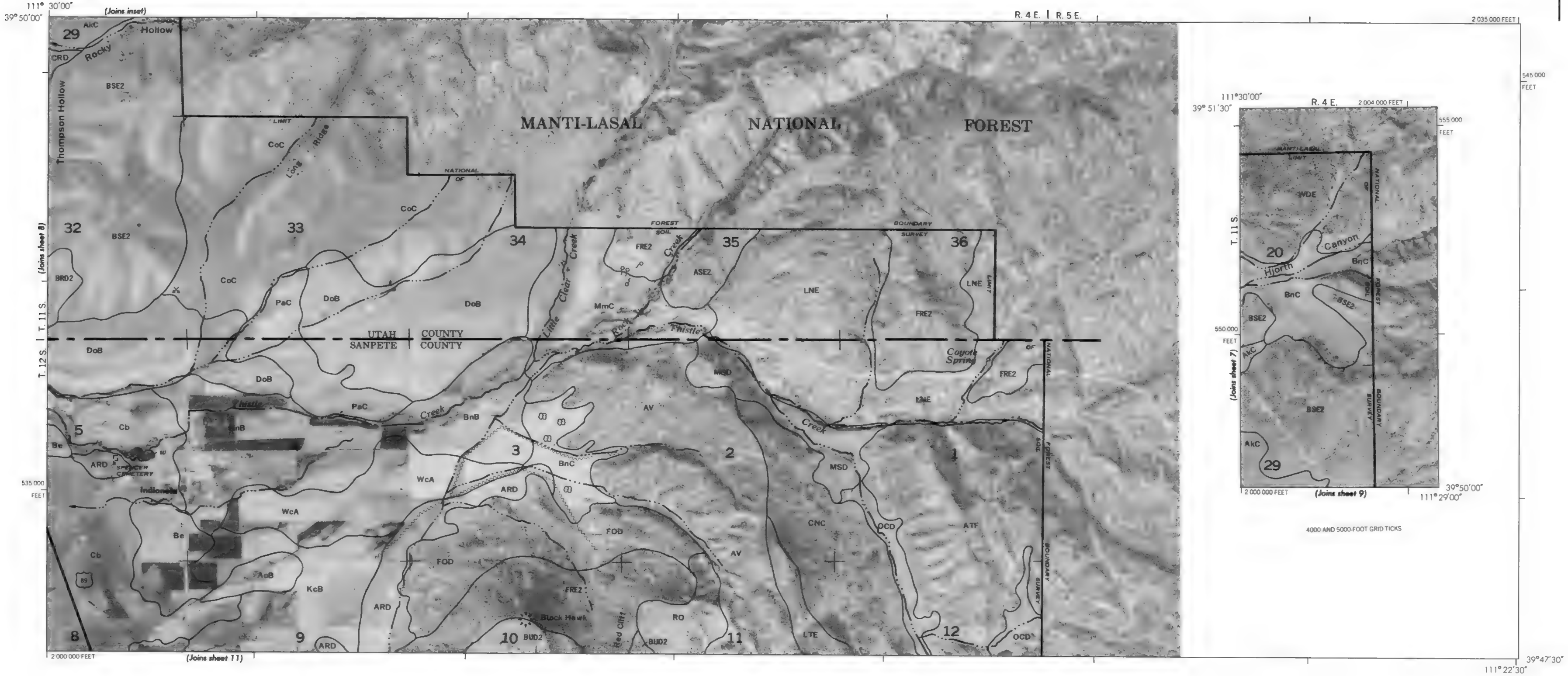


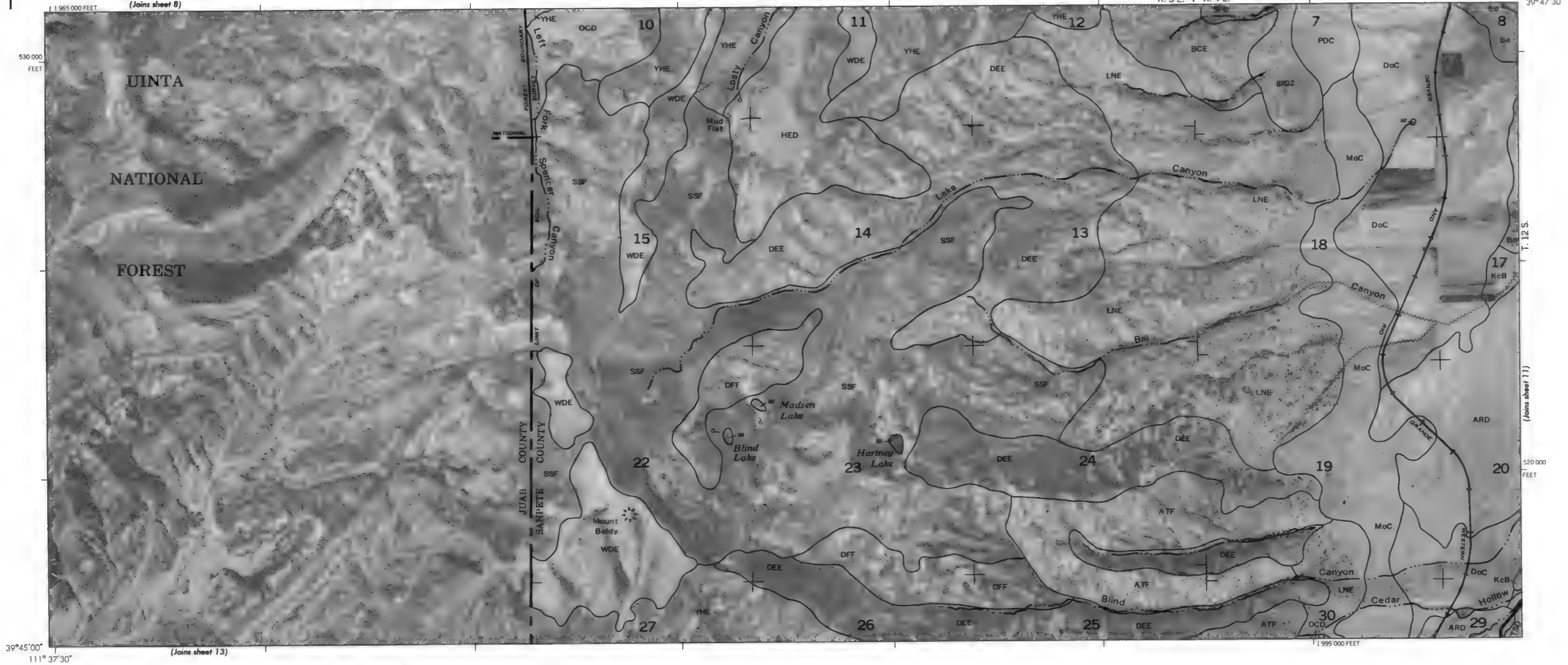


3000 AND 5000-FOOT GRID TICKS

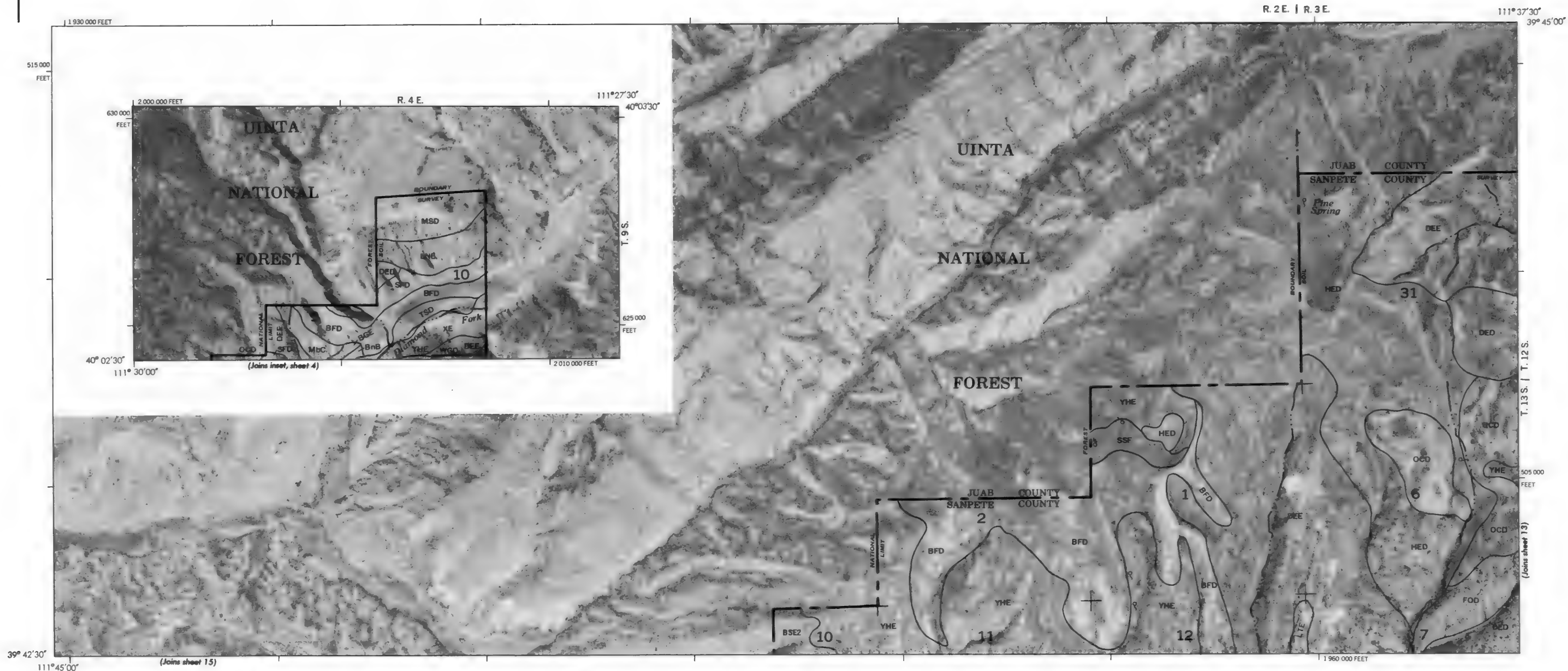




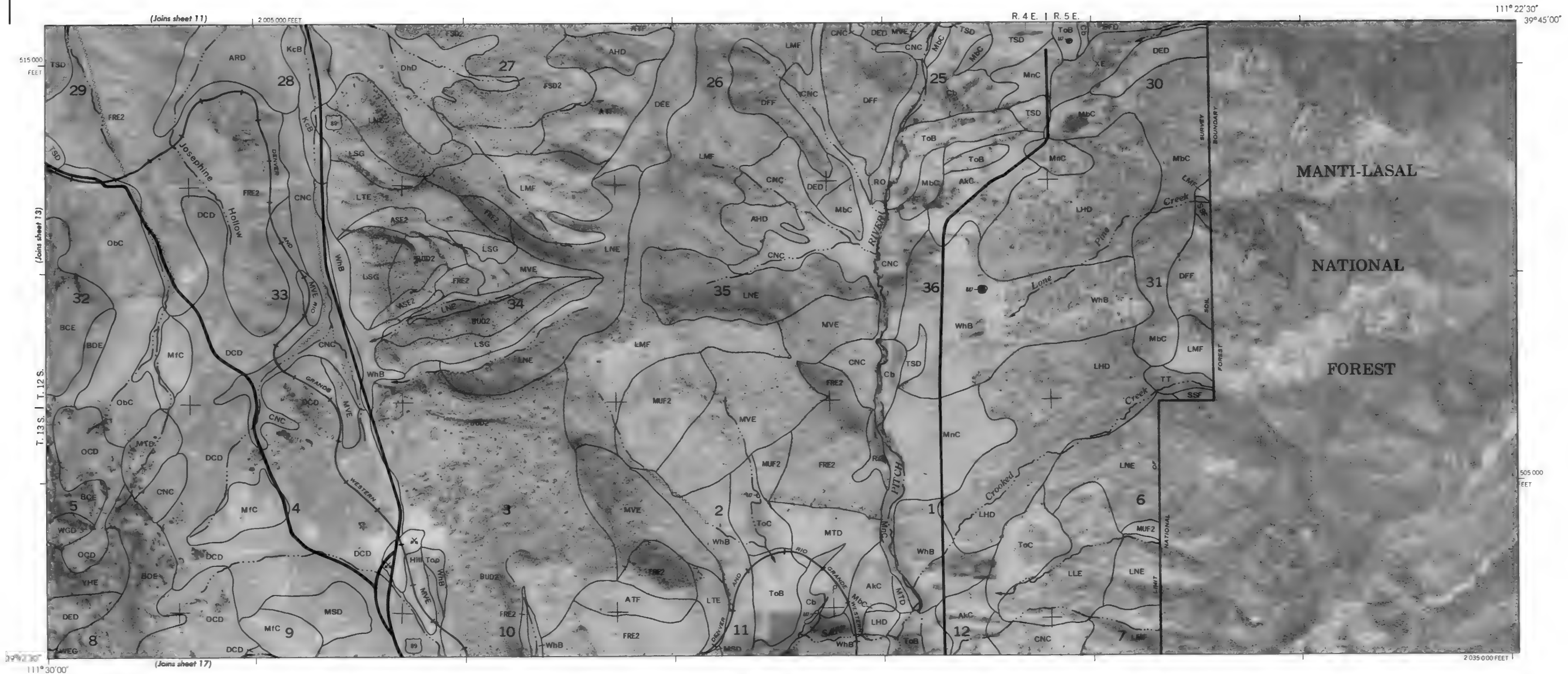


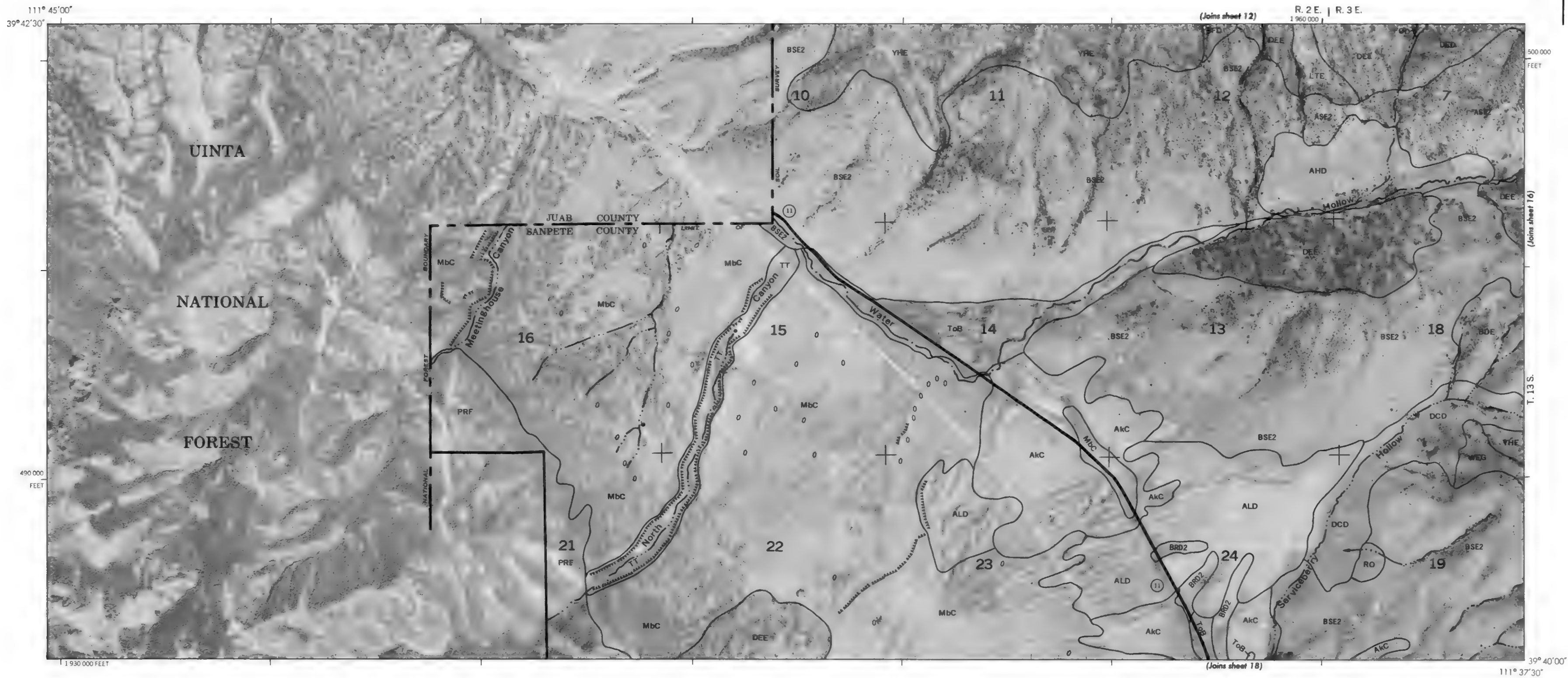


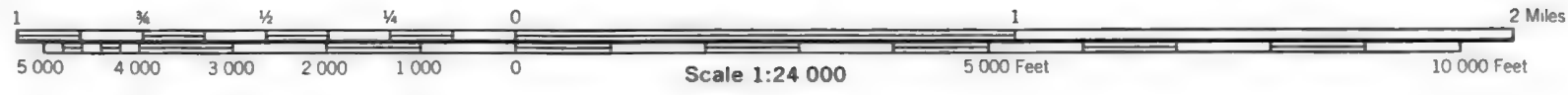
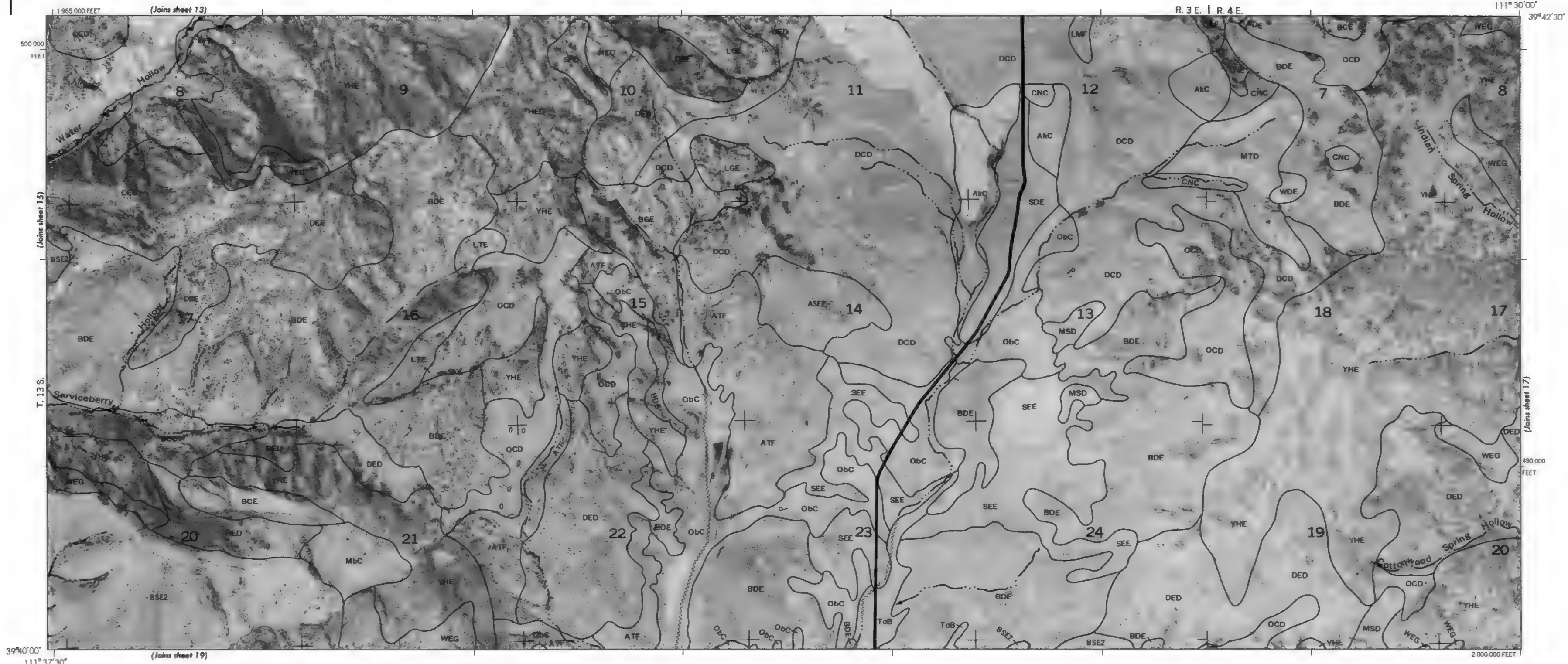




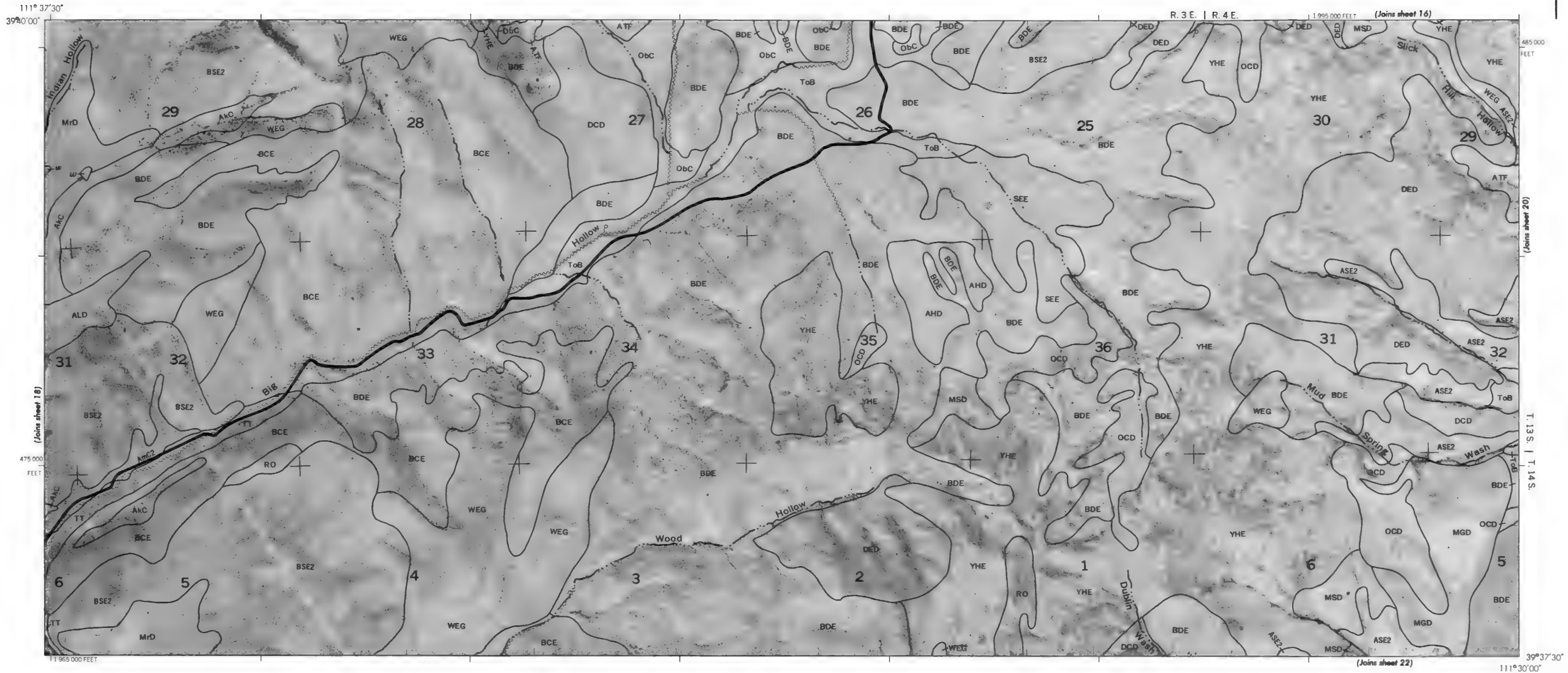


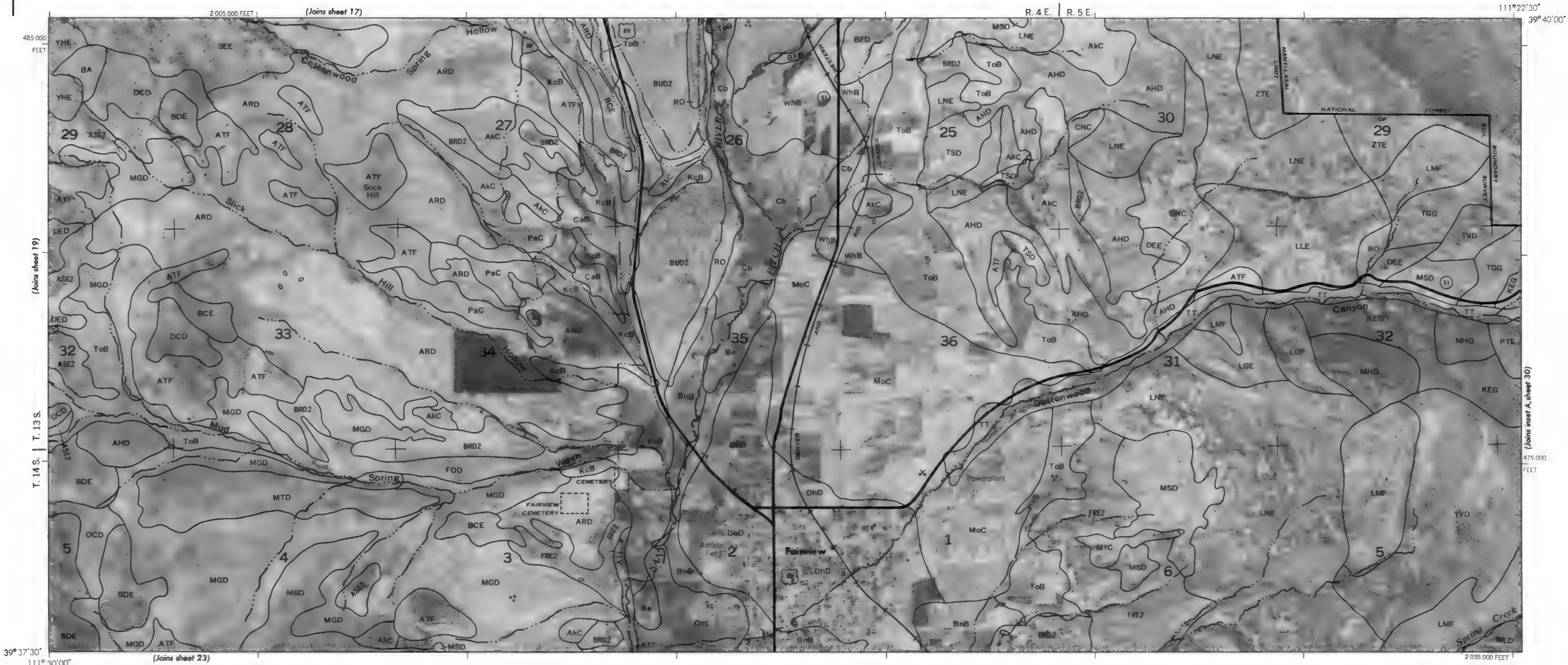


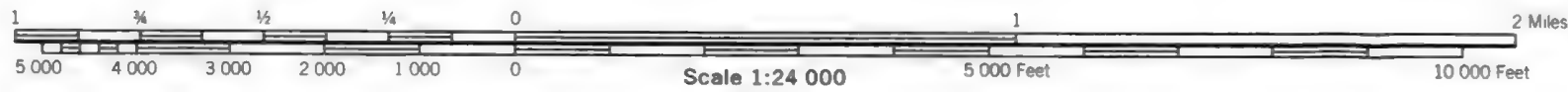
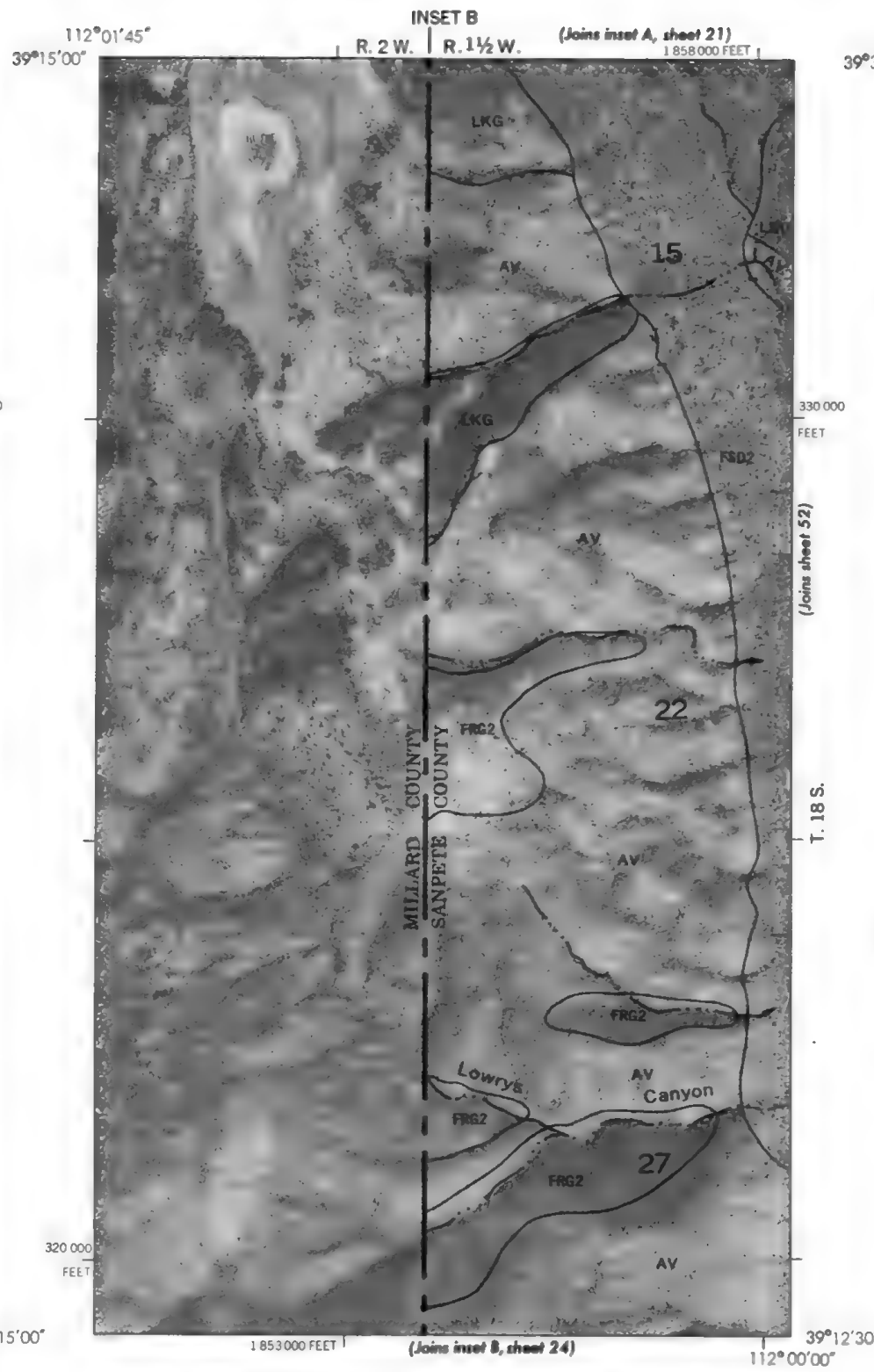
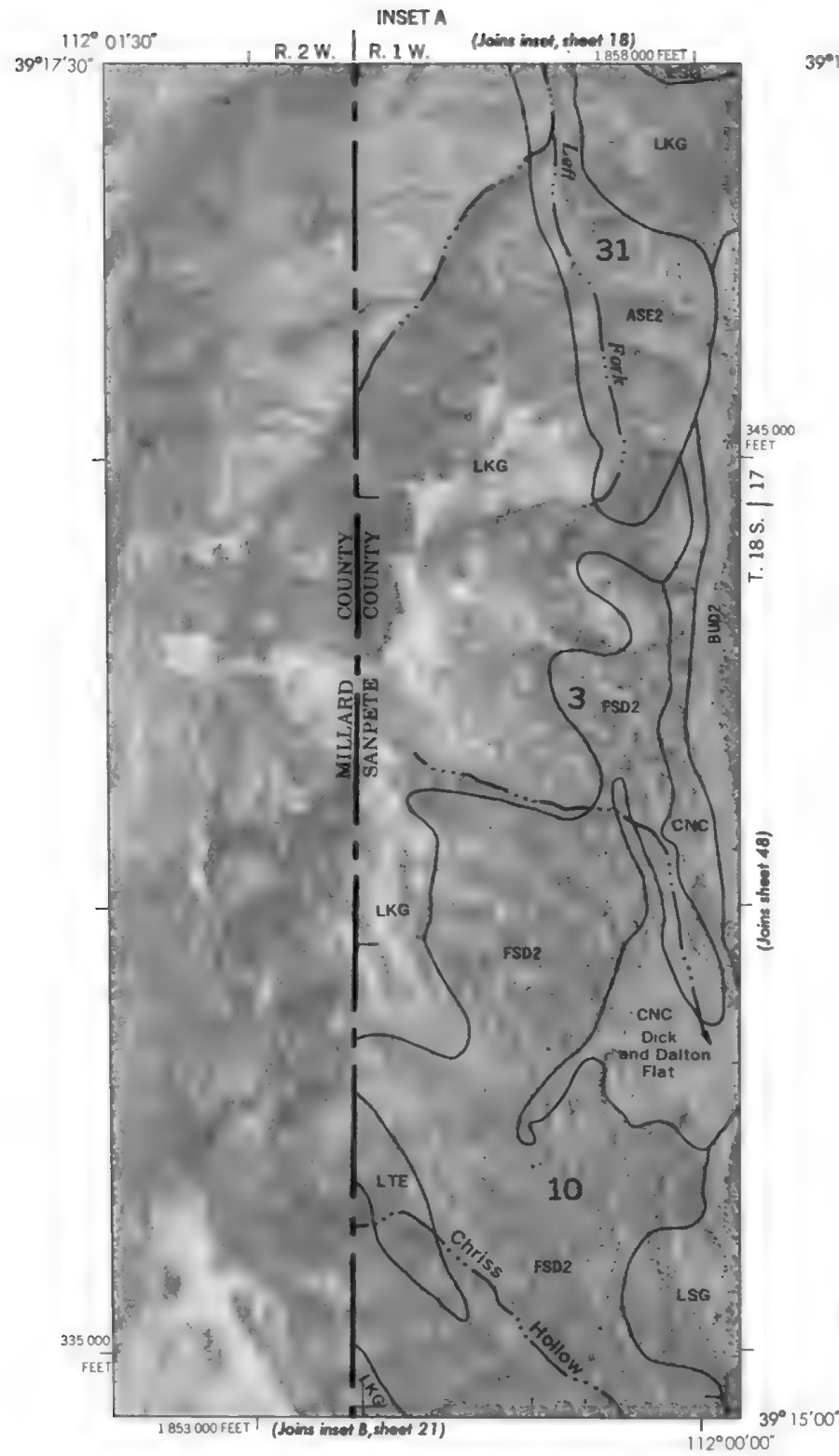


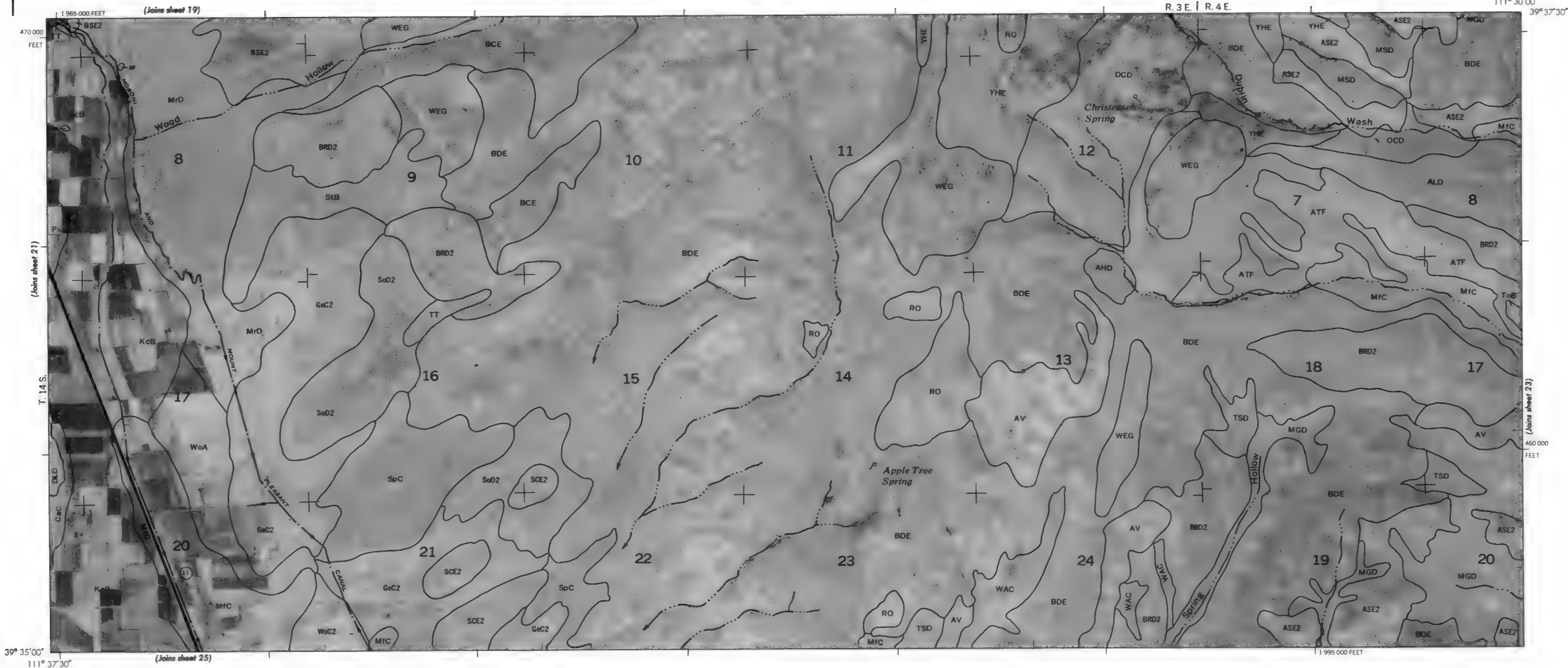














111° 30' 00"
39° 37' 30"

R. 4 E. | R. 5 E.

(Joins sheet 20)

2 035 000 FEET

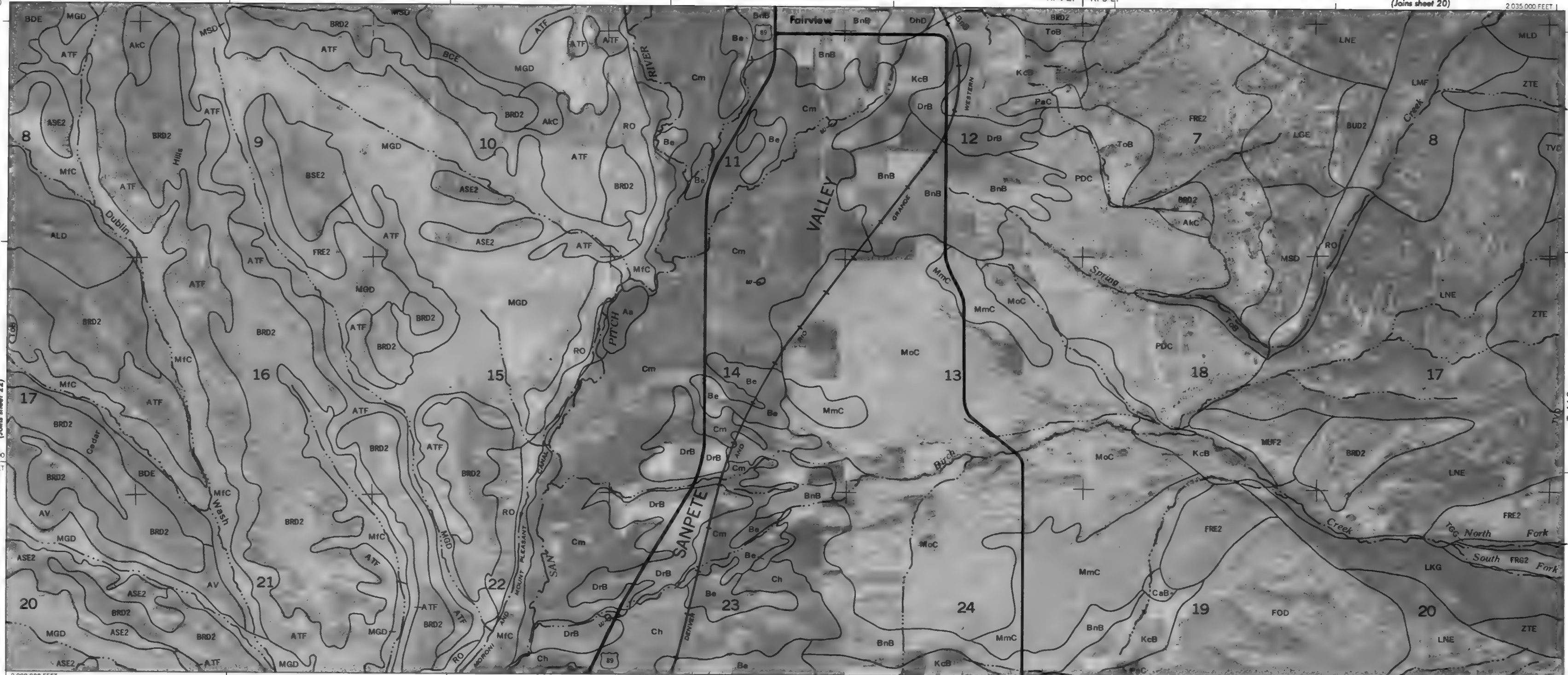
470 000
FEET

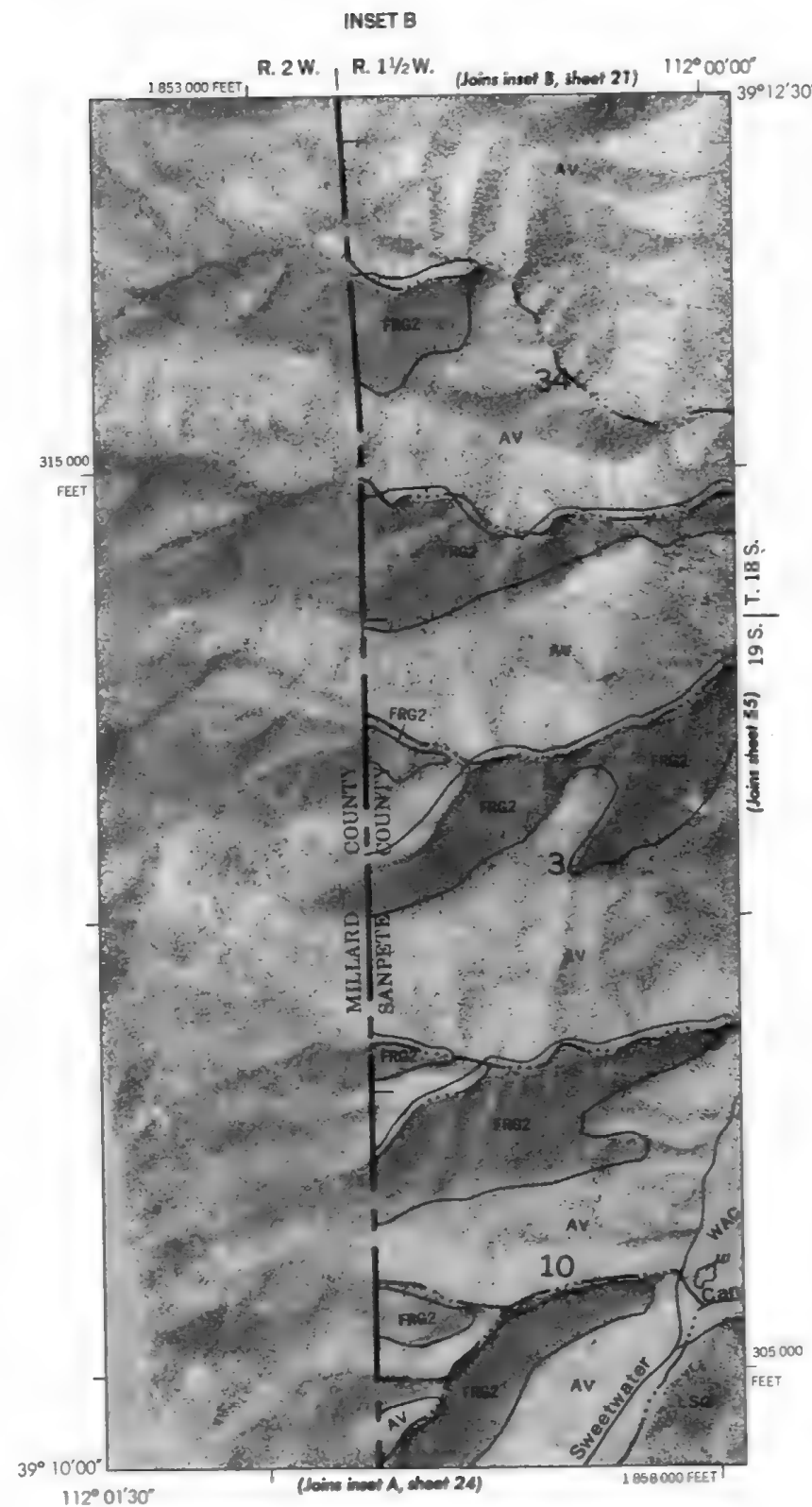
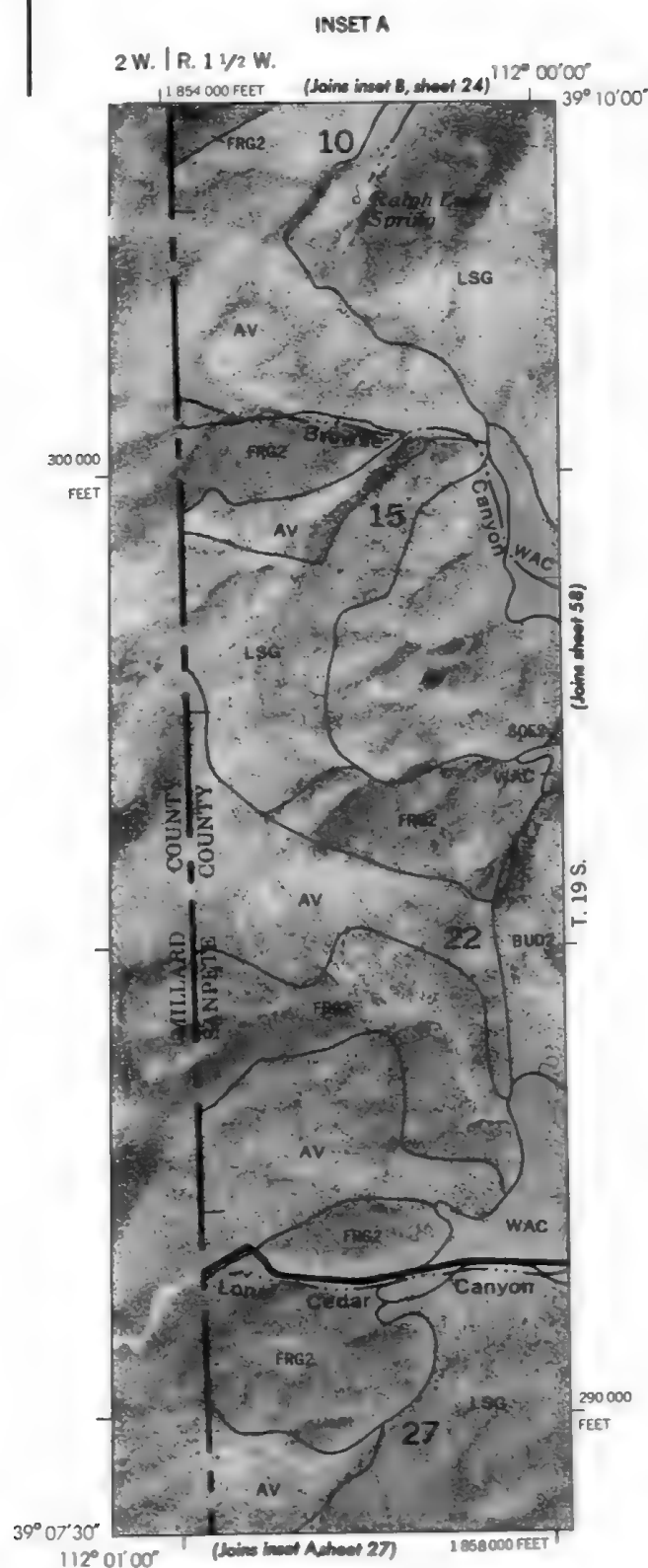
(Joins inset B, sheet 34)

T. 14 S.

111° 22' 30"
39° 35' 00"

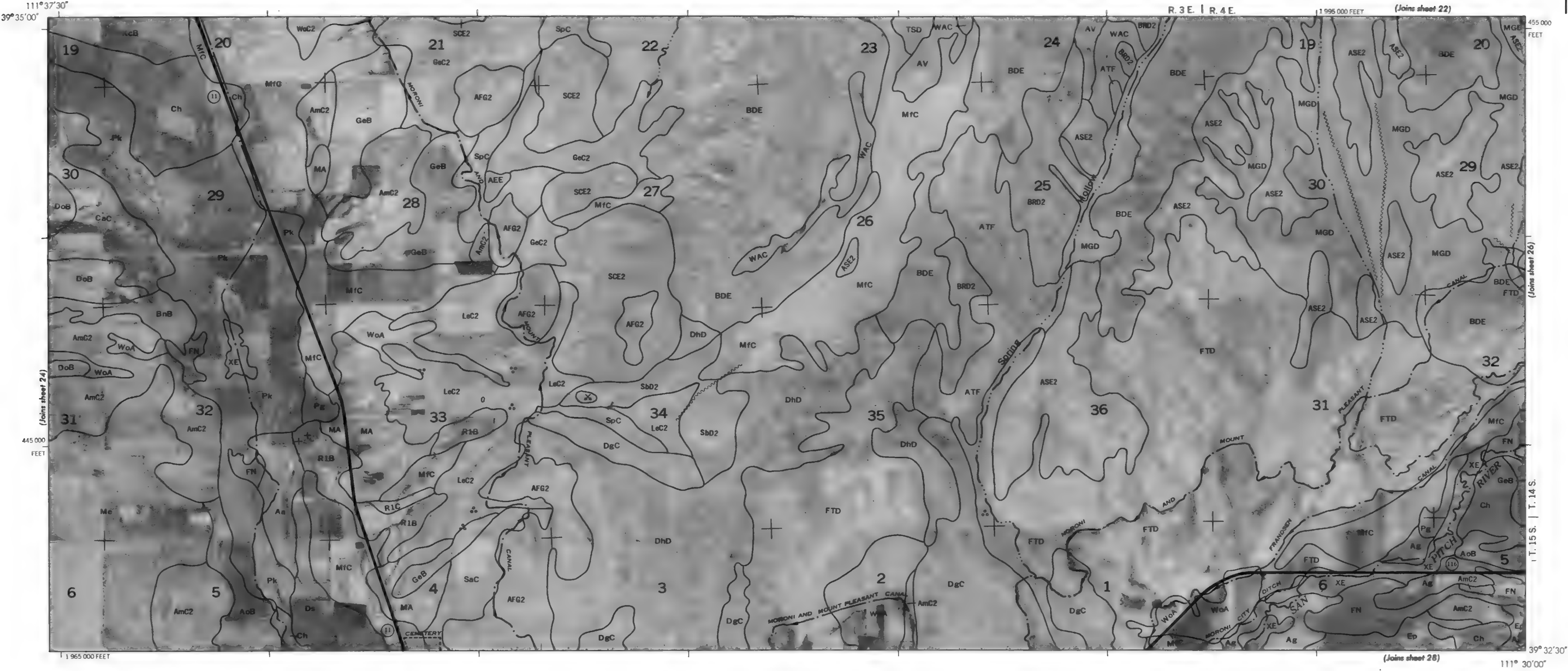
(Joins sheet 26)

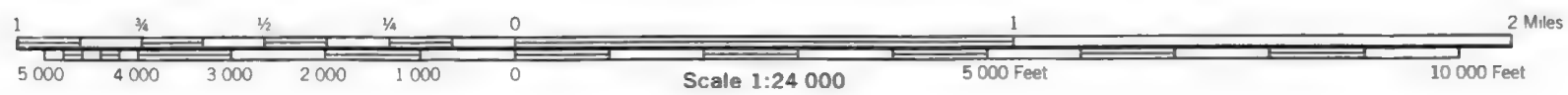


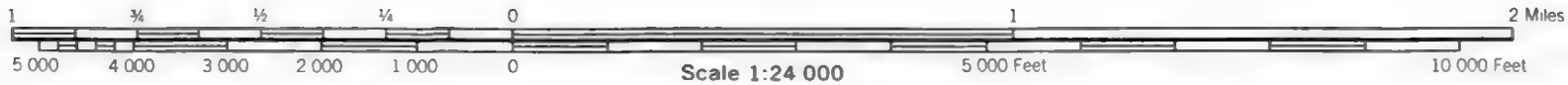


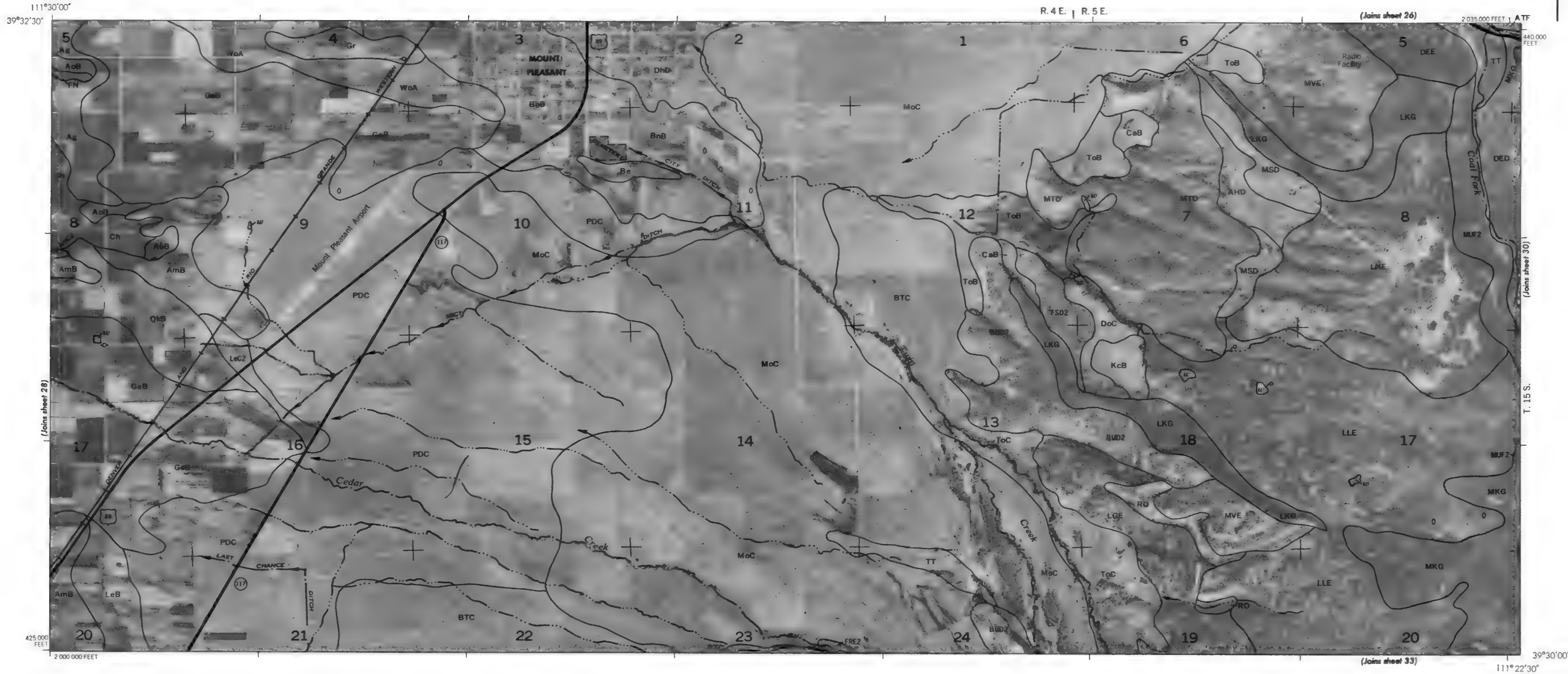
4000 AND 5000-FOOT GRID TICKS







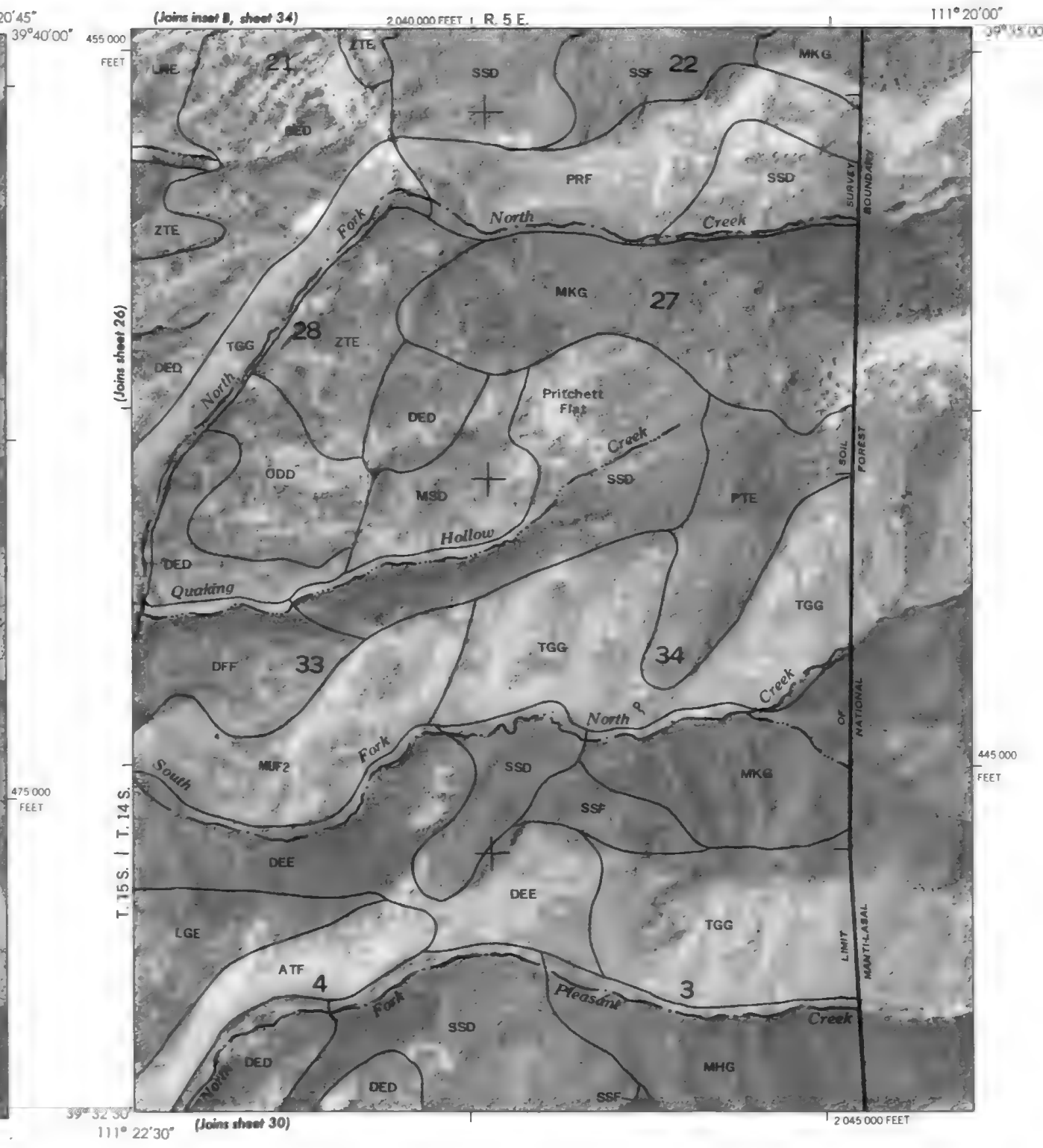
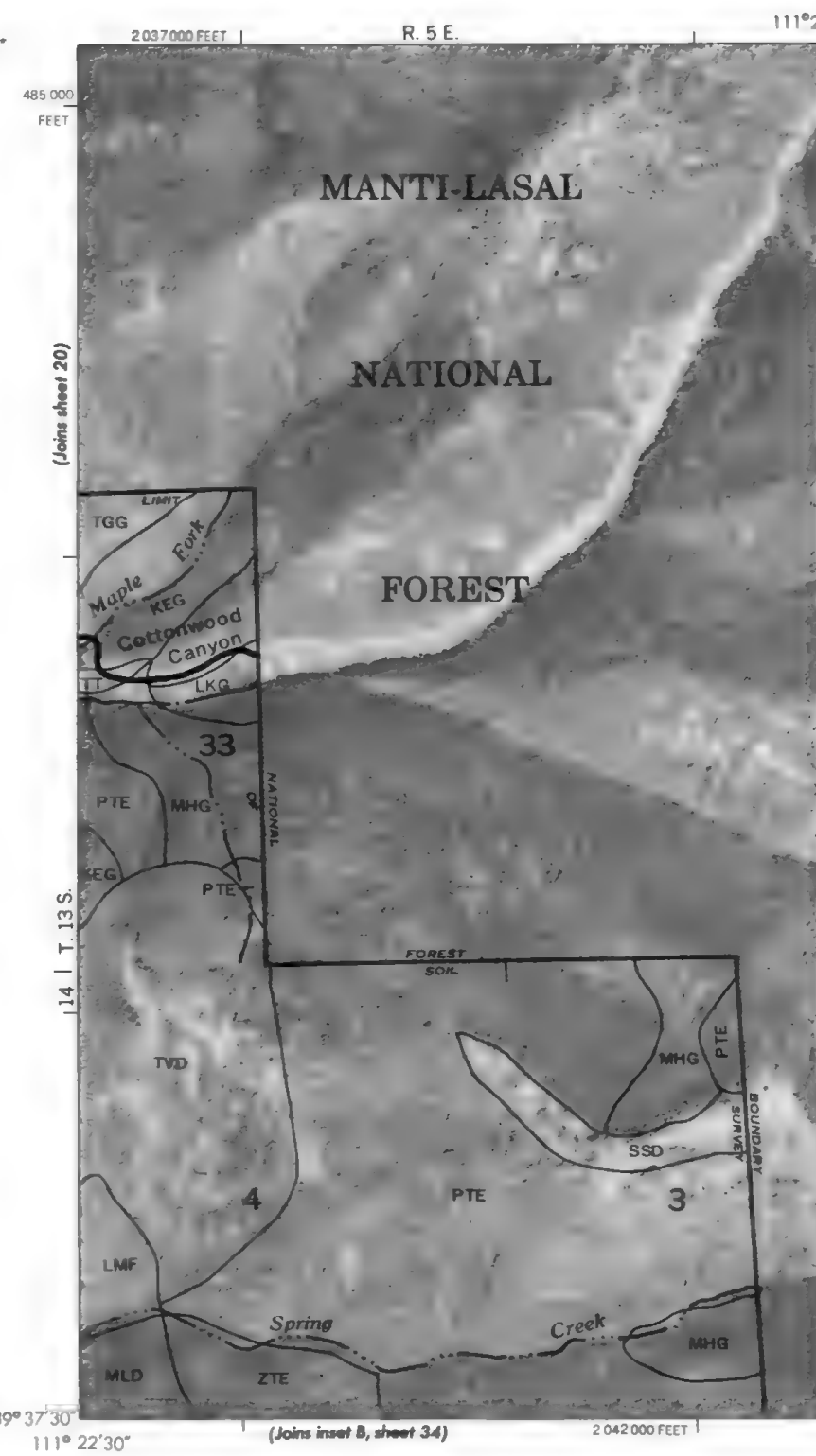
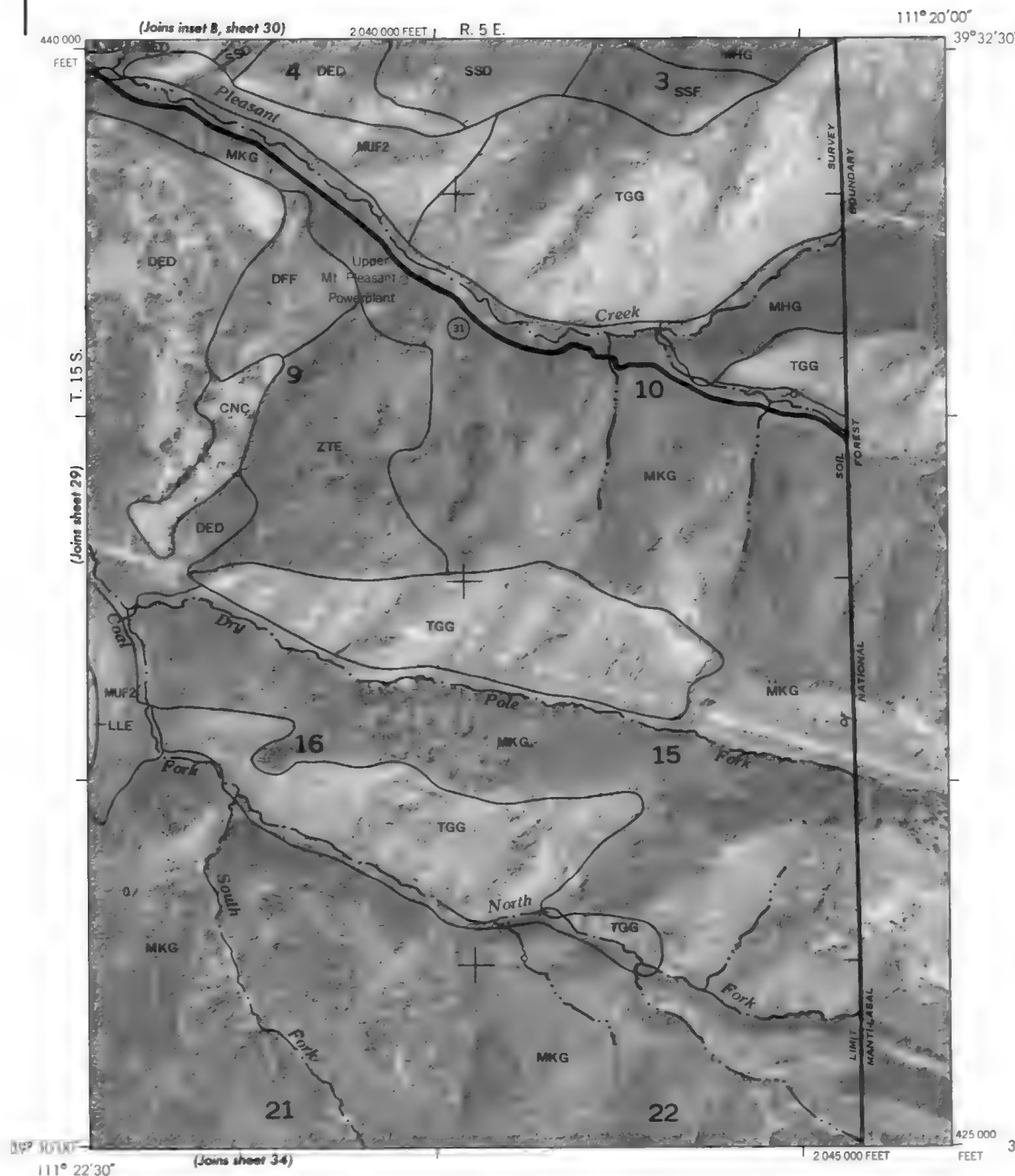


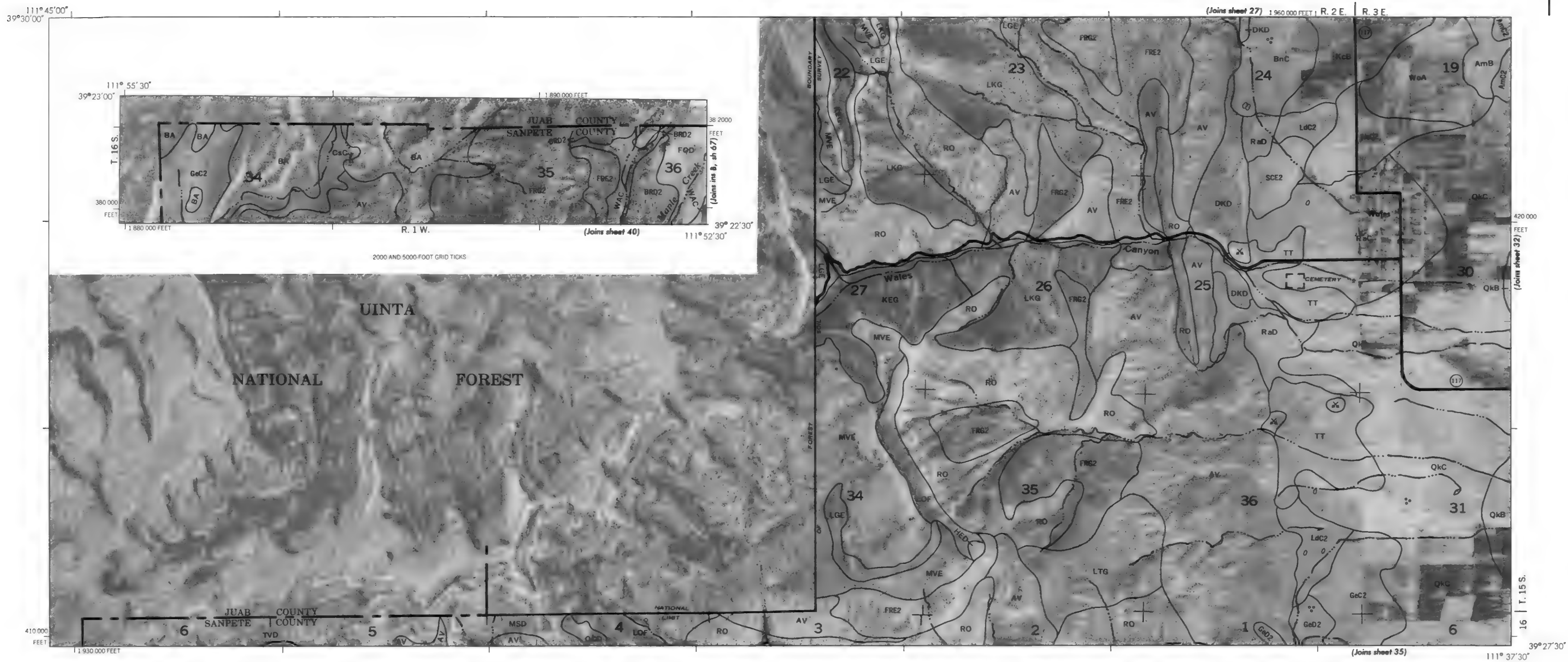


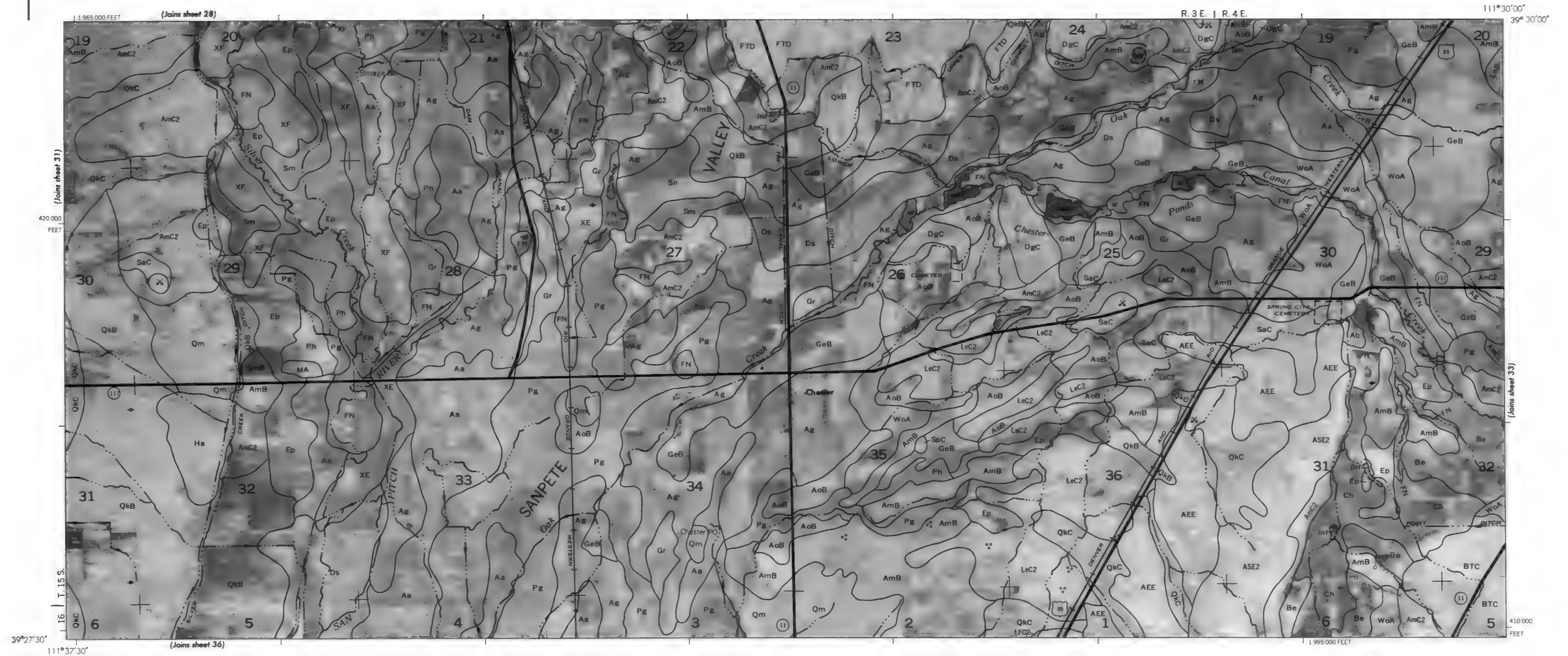


INSET A

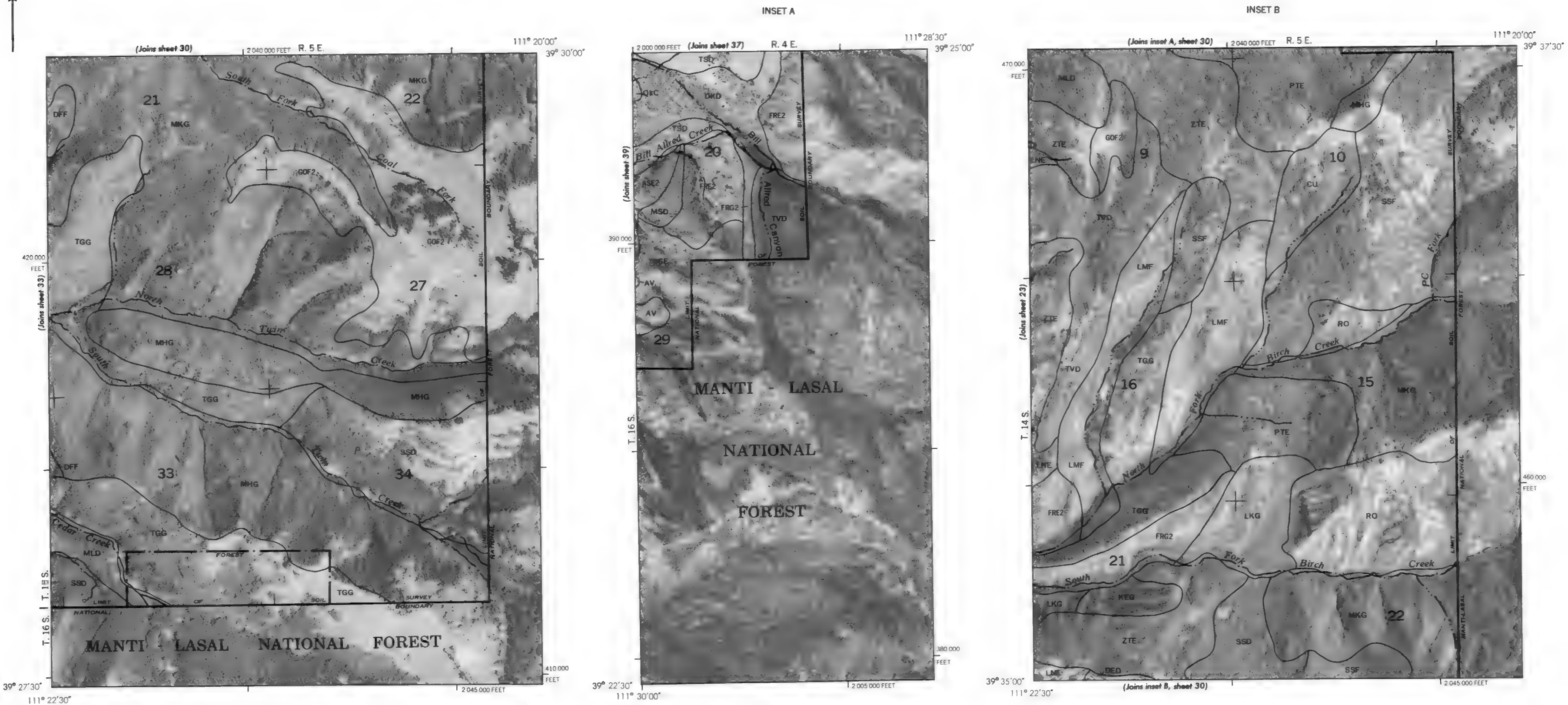
INSET B

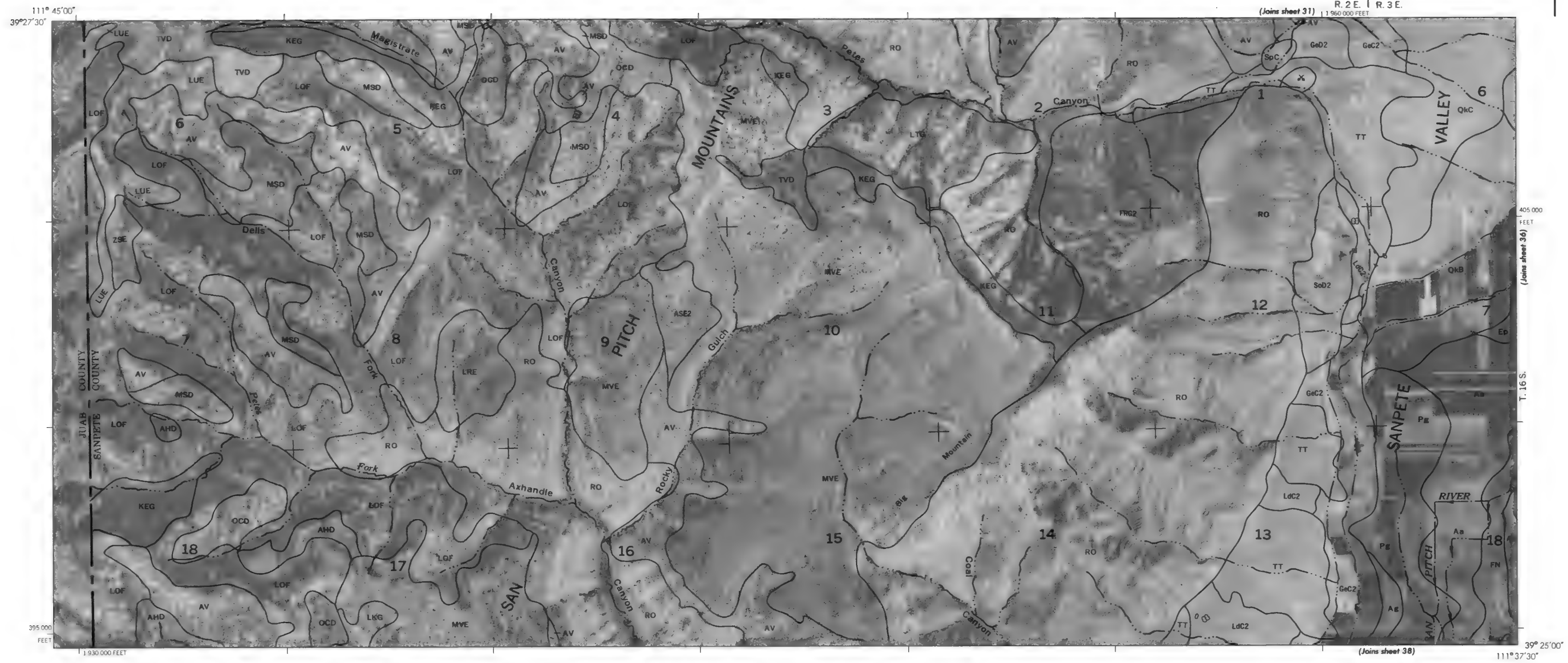




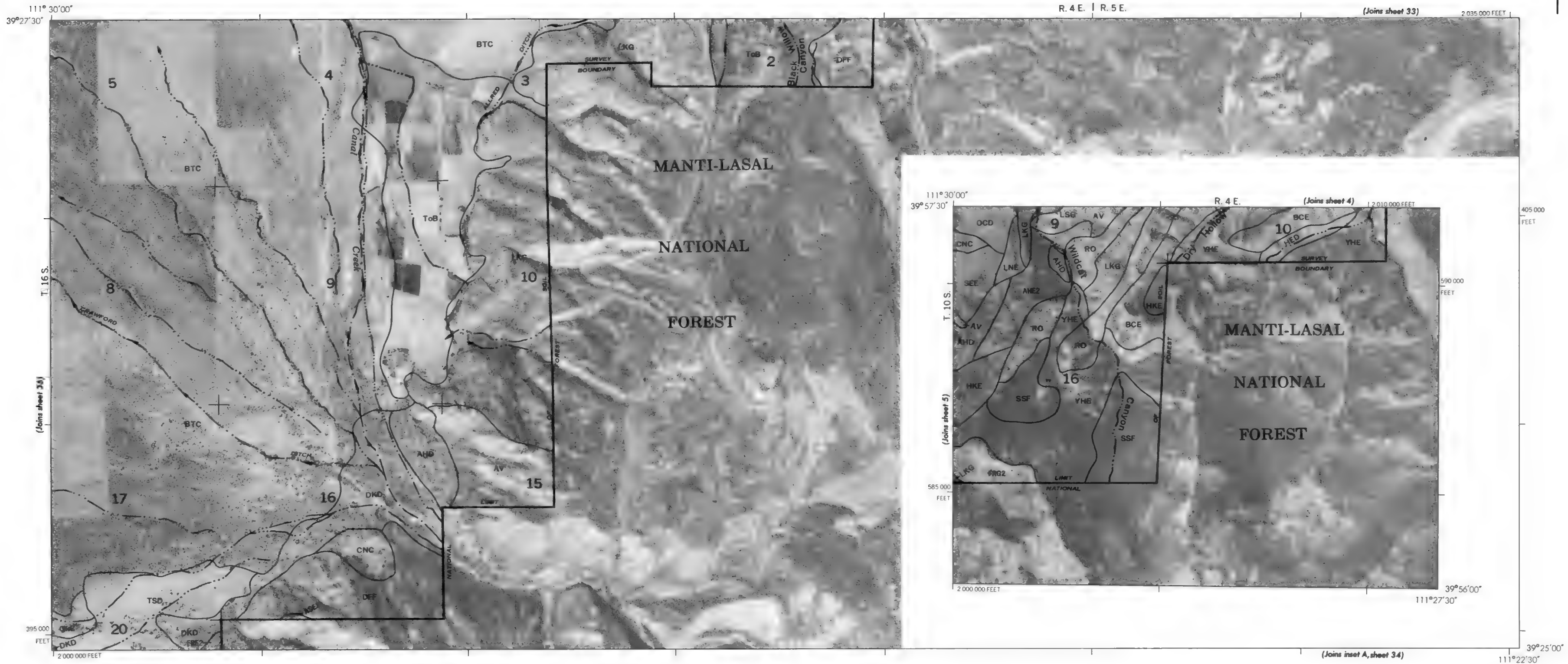








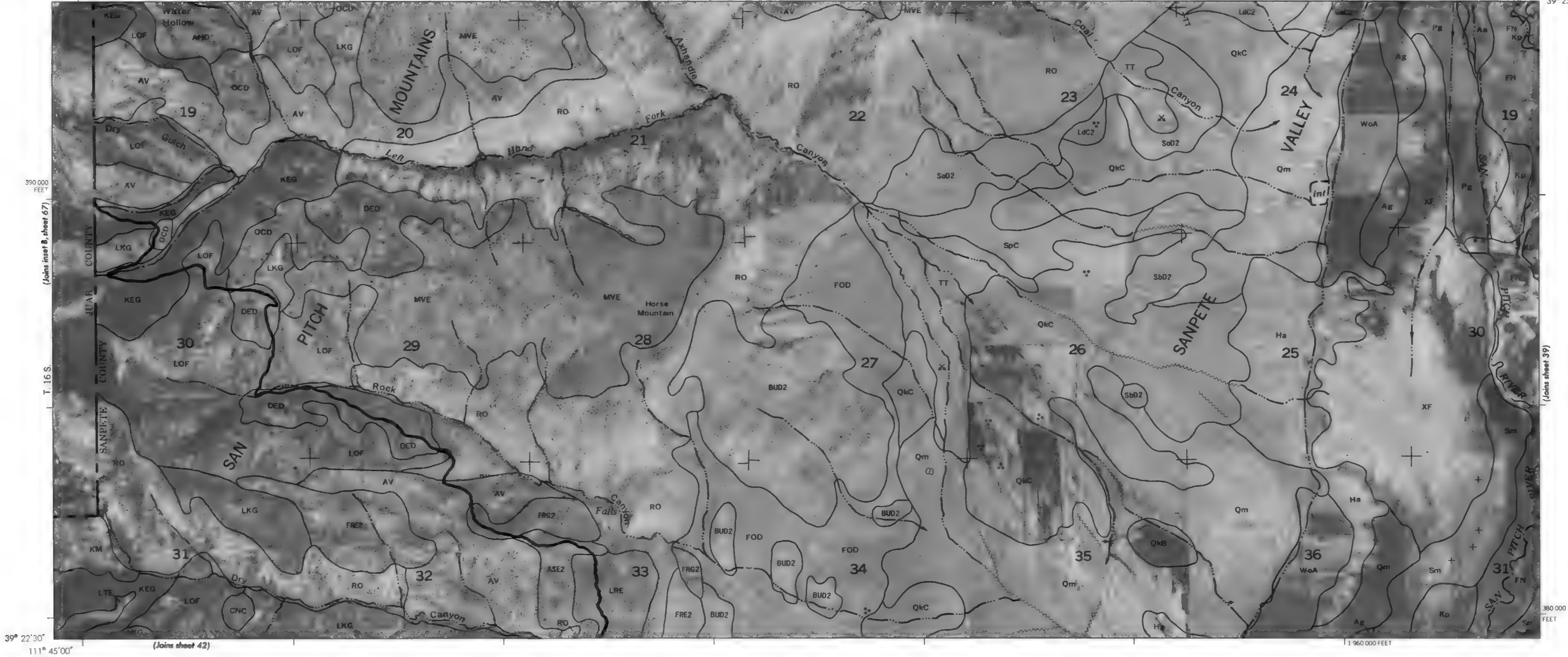






R. 1 E. | R. 2 E. (Joins sheet 35)

R. 2 E. | R. 3 E. 111° 37' 30" 39° 25' 00"





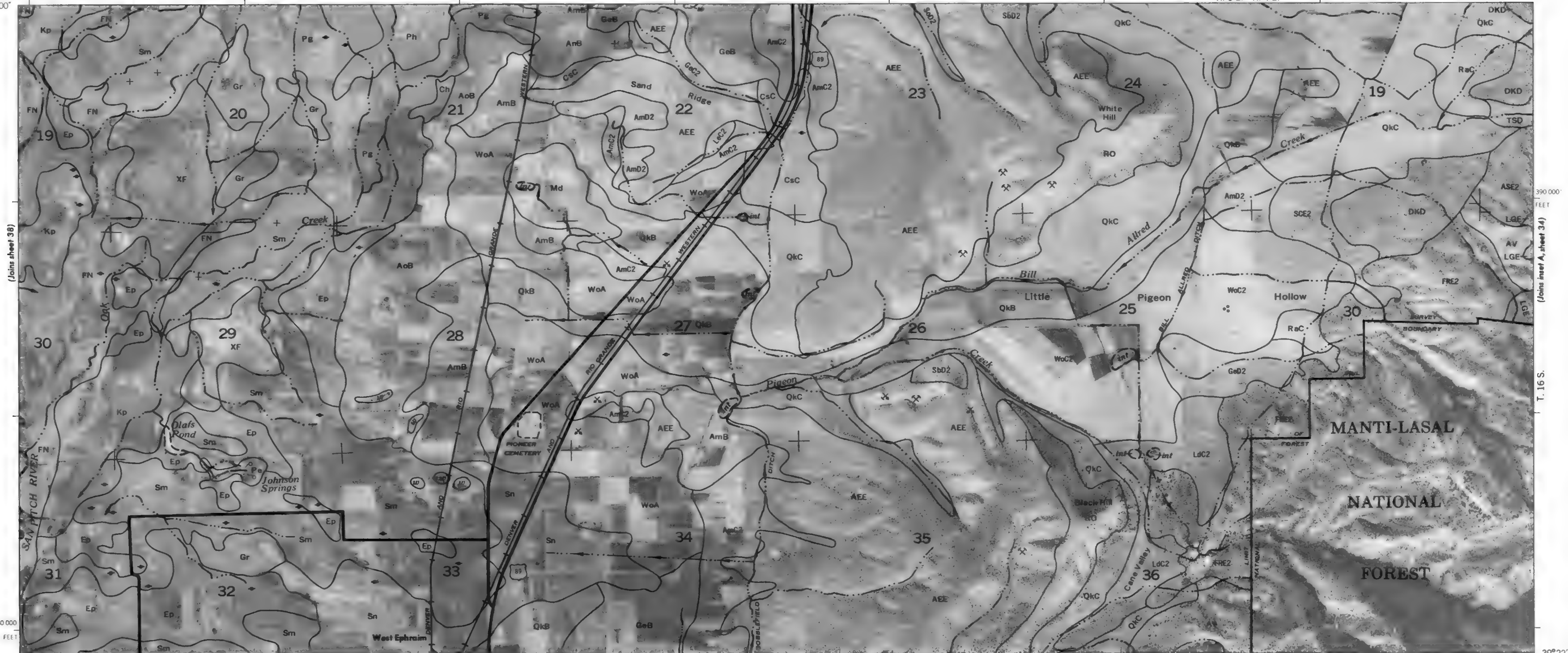
111°37'30"

39°25'00"

R. 3 E. | R. 4 E.

1 995 000 FEET

(Joins sheet 36)



390 000' FEET

(Joins sheet 34)

T. 16 S.

380 000 FEET

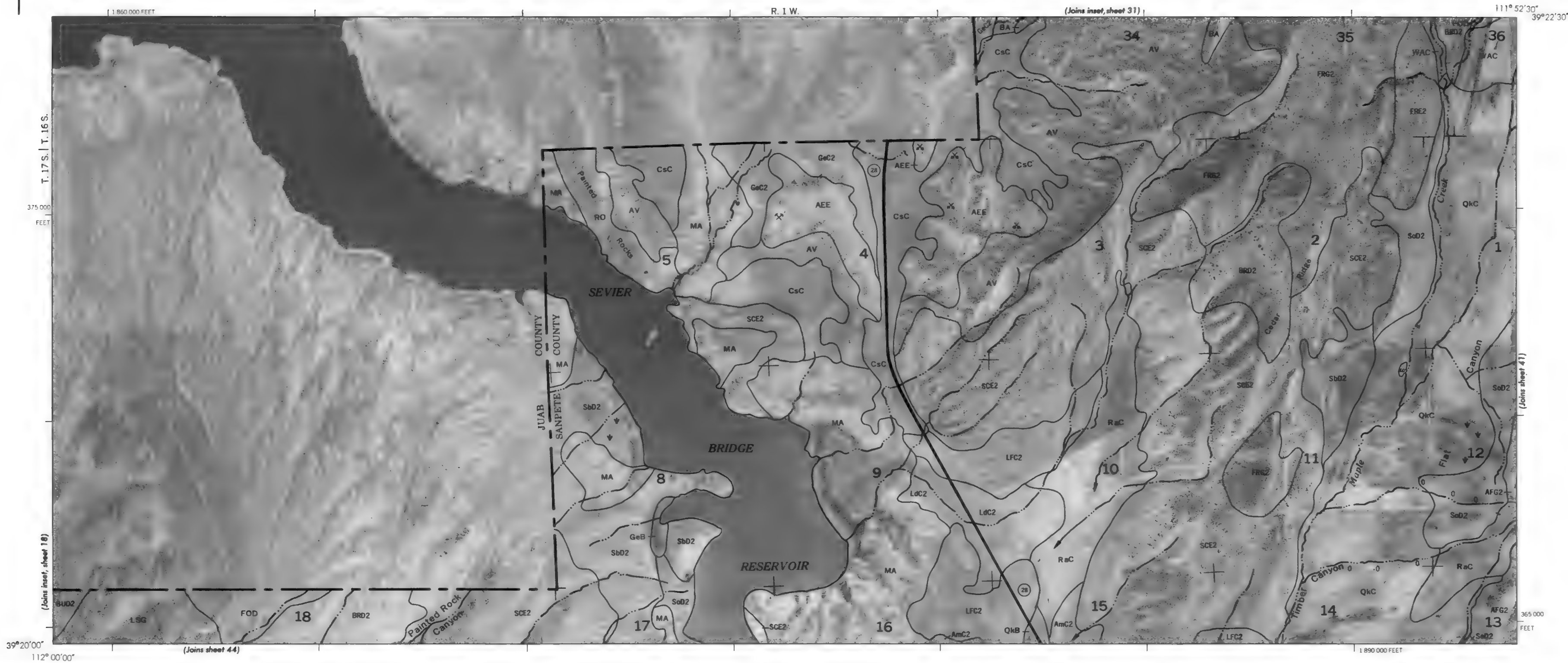
1 965 000 FEET

(Joins sheet 43)

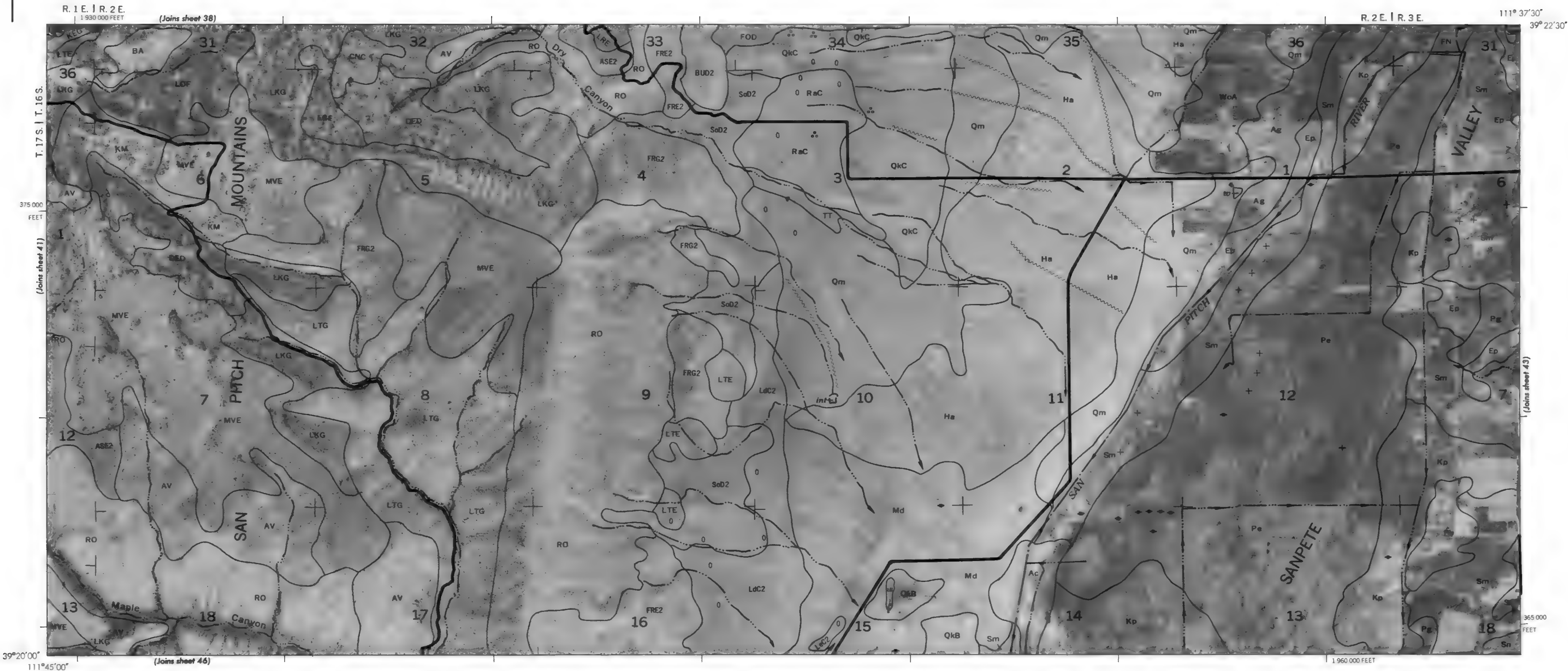
39°22'30"

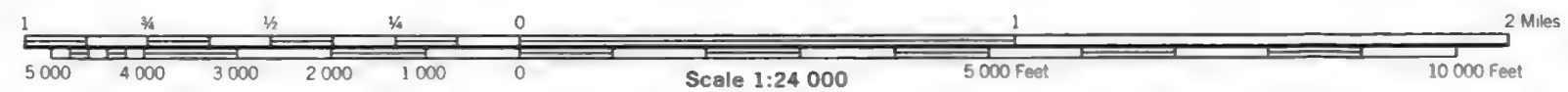
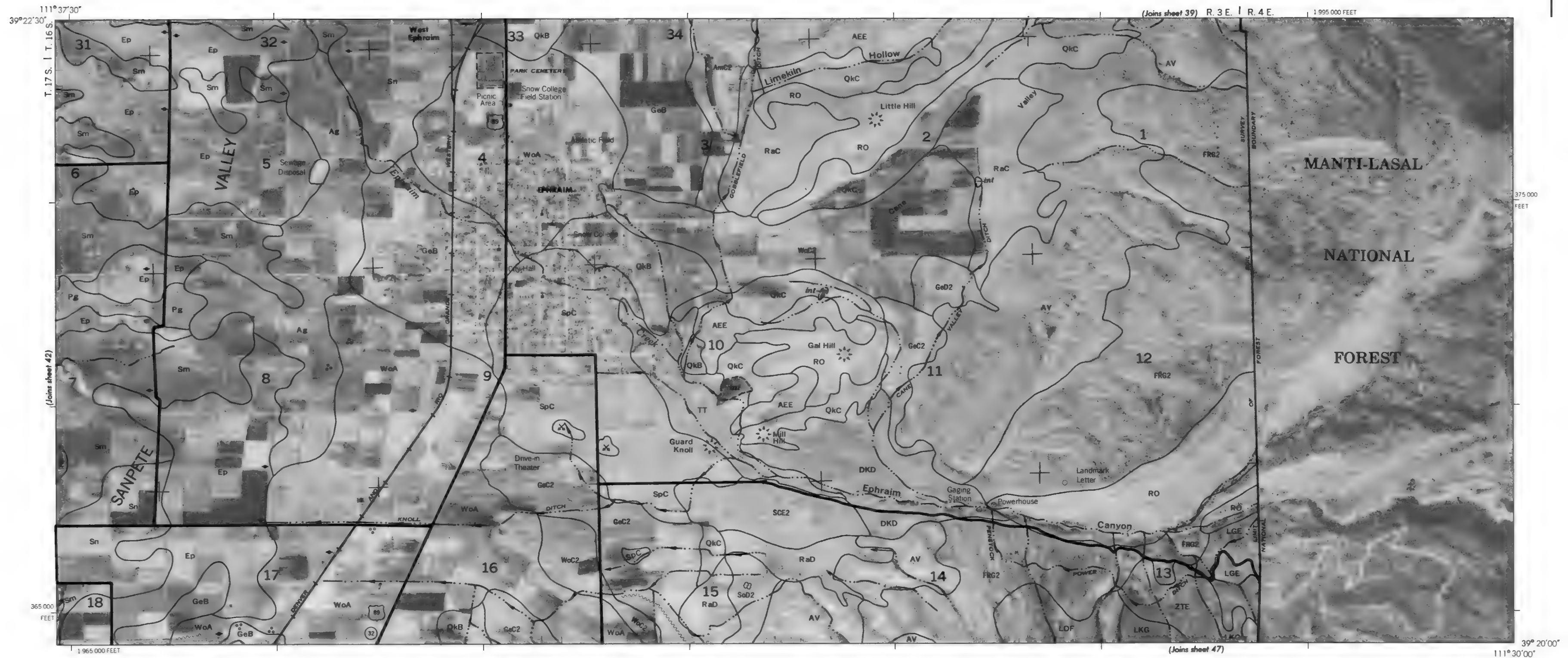
111°30'00"

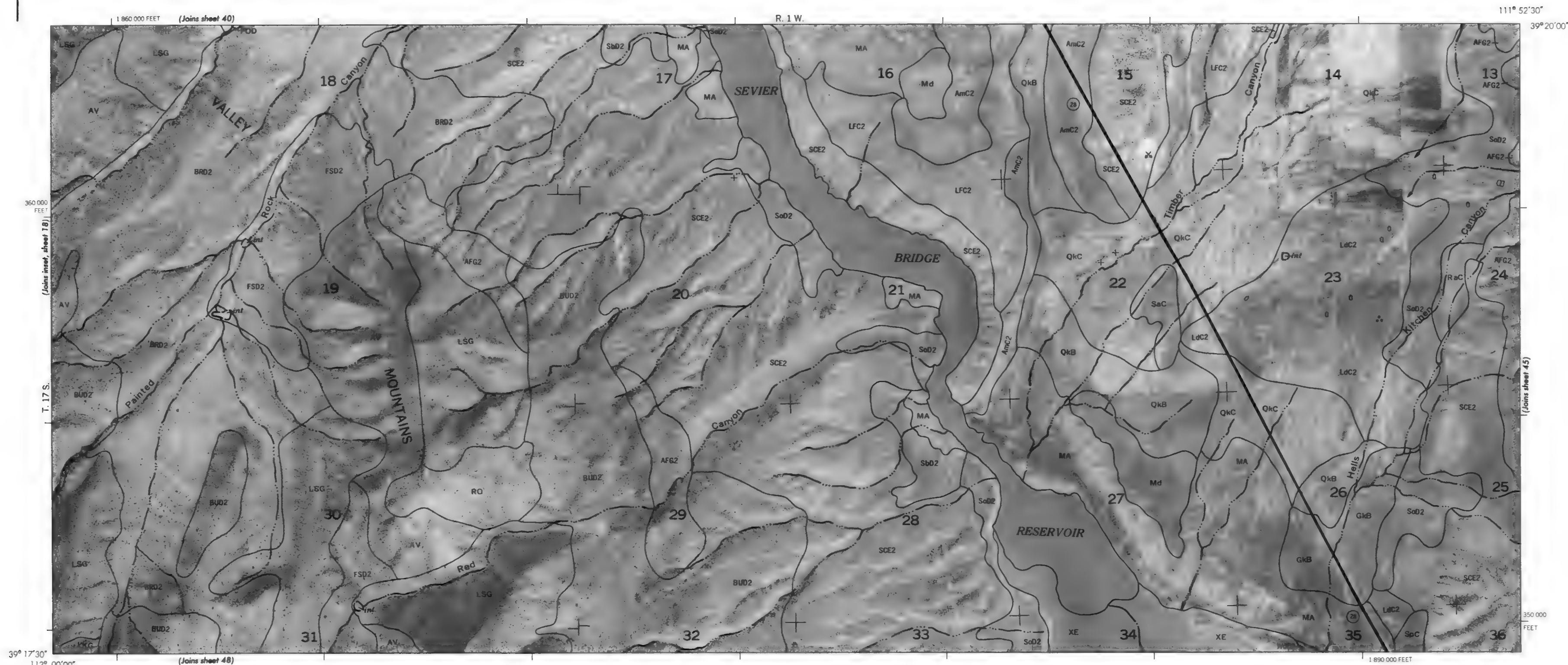


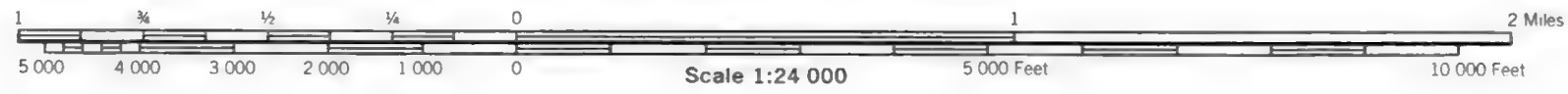






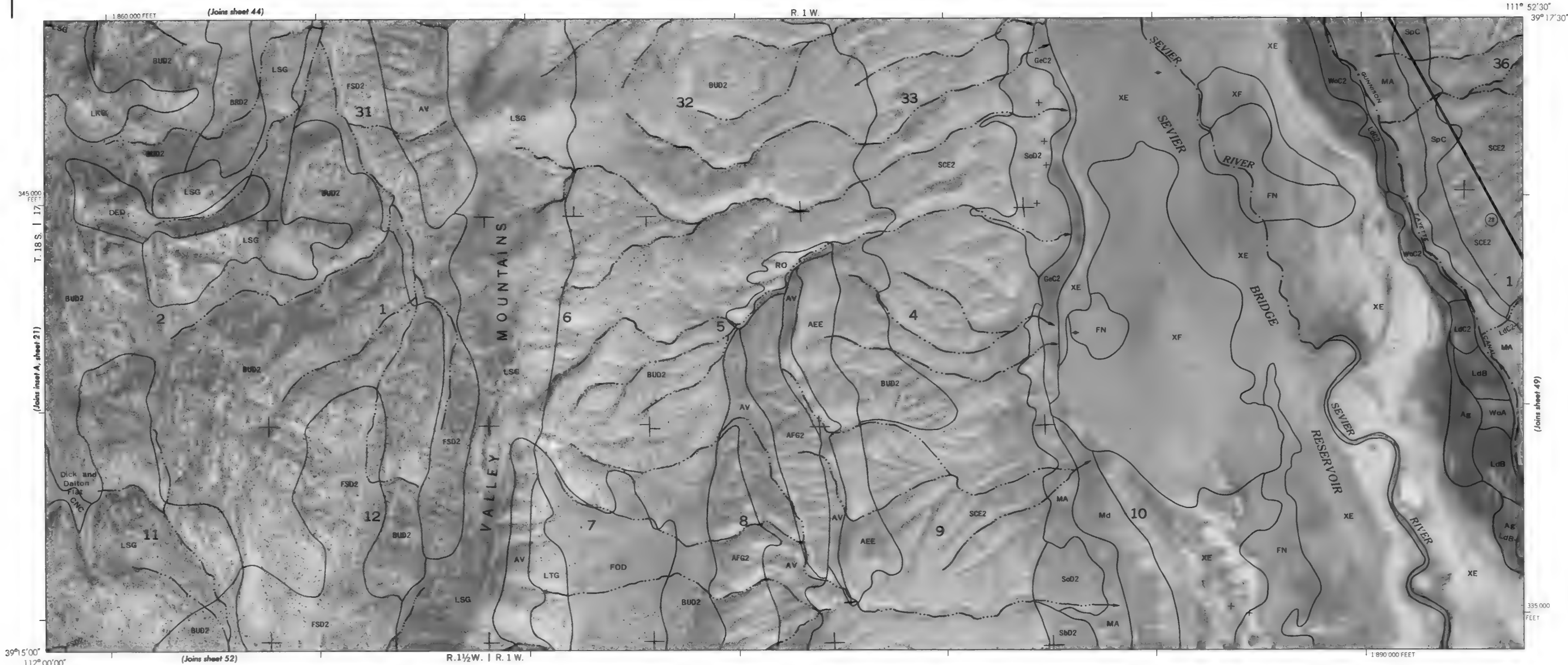








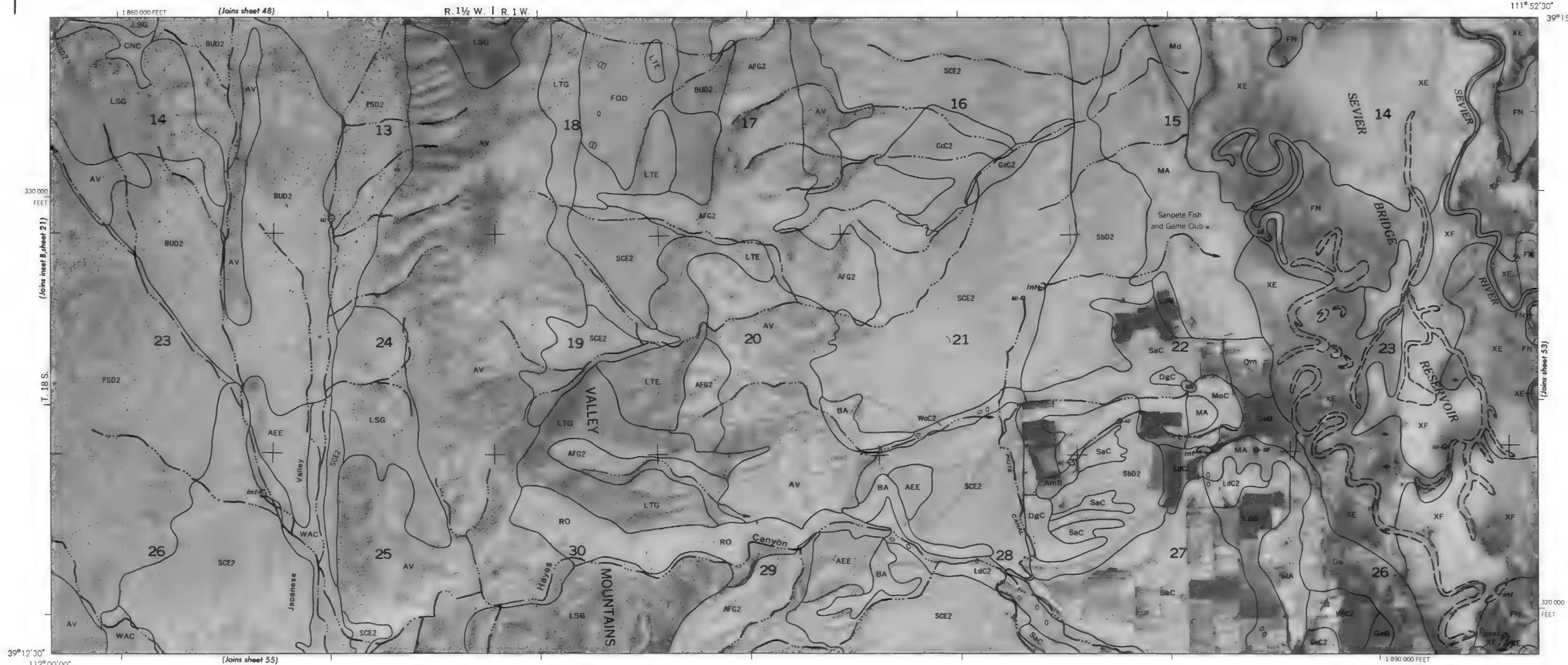


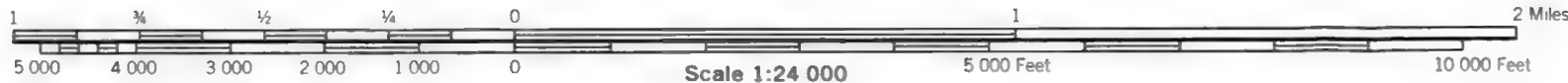
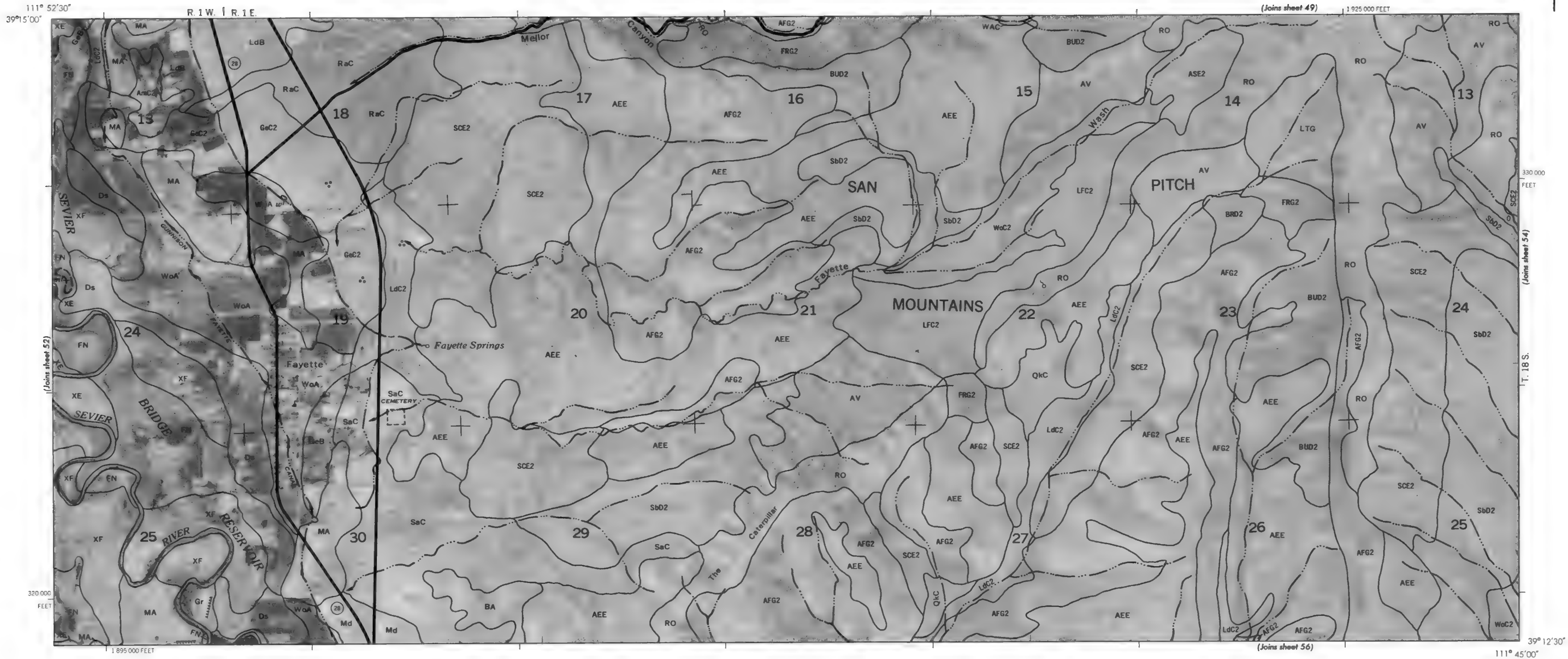


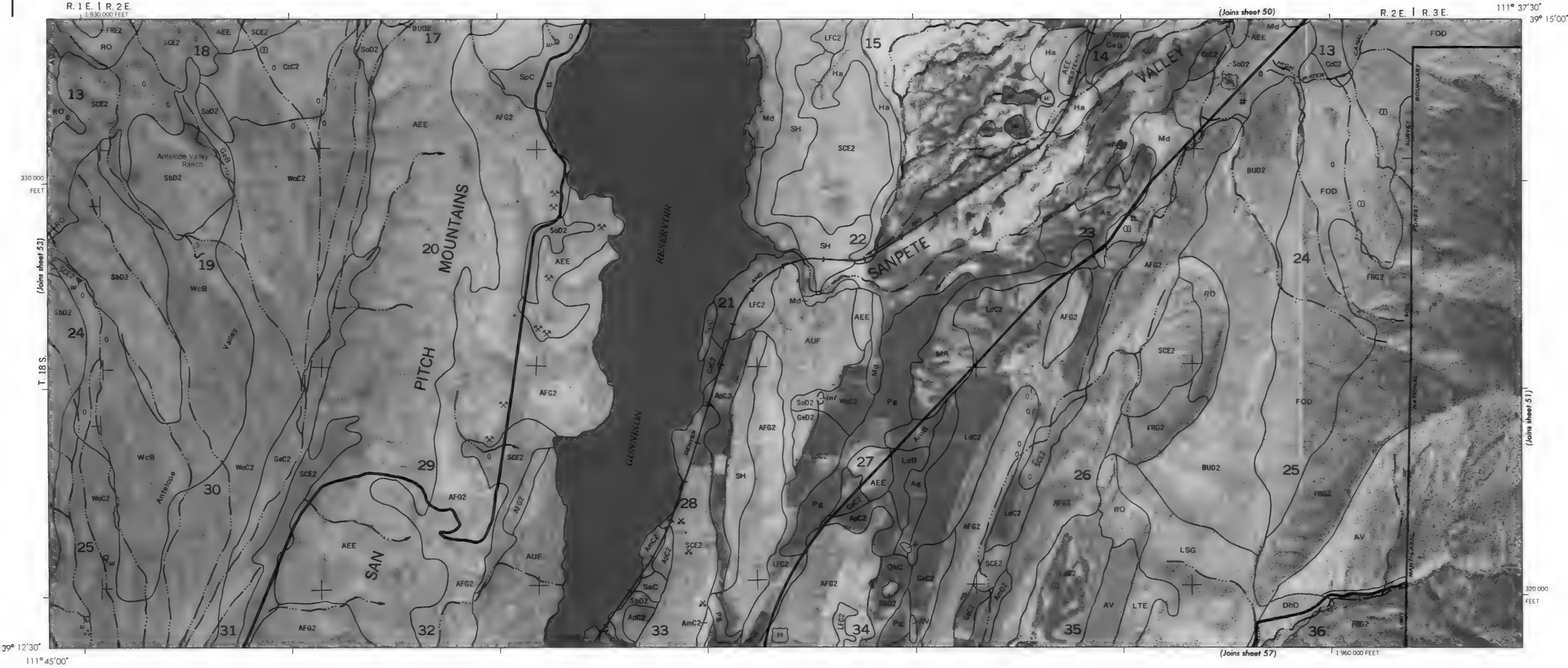


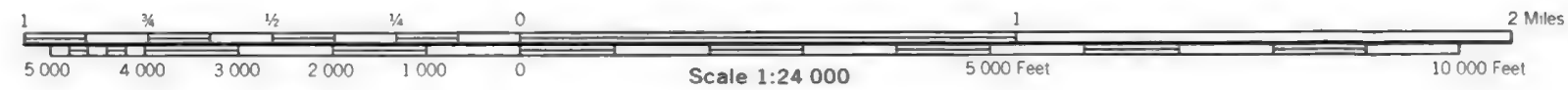
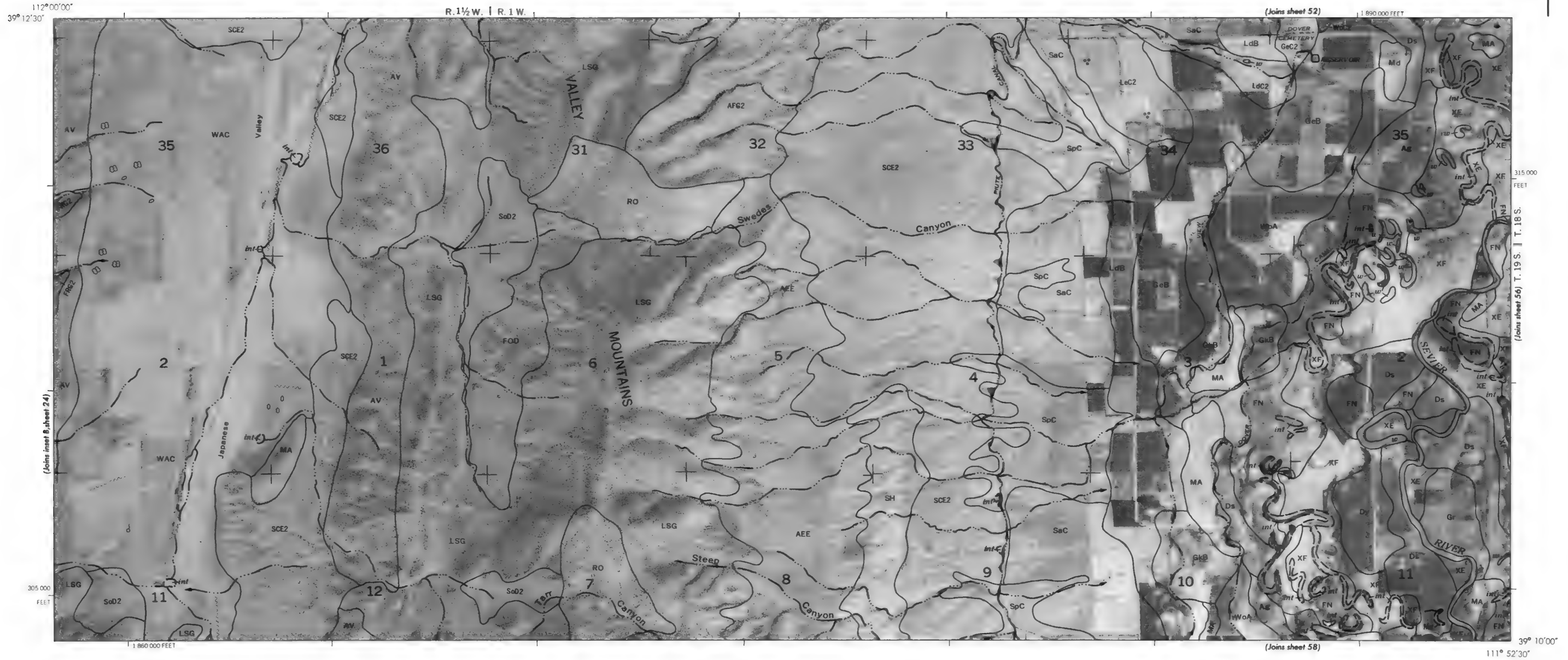






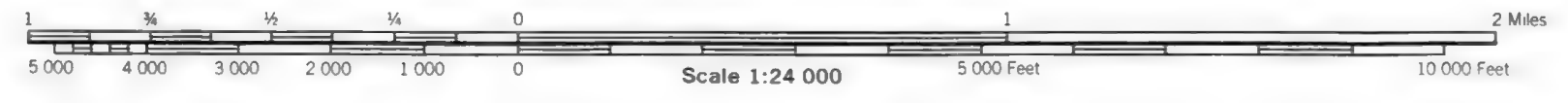
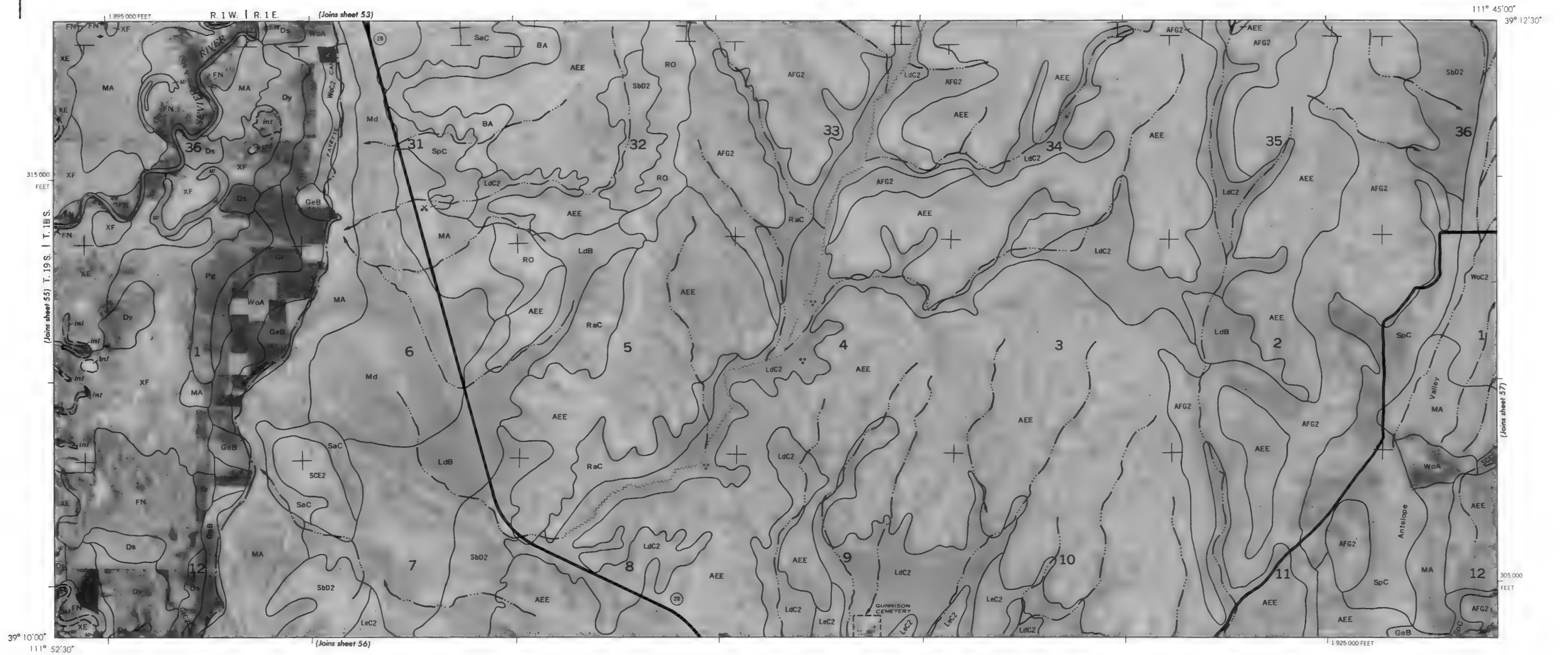








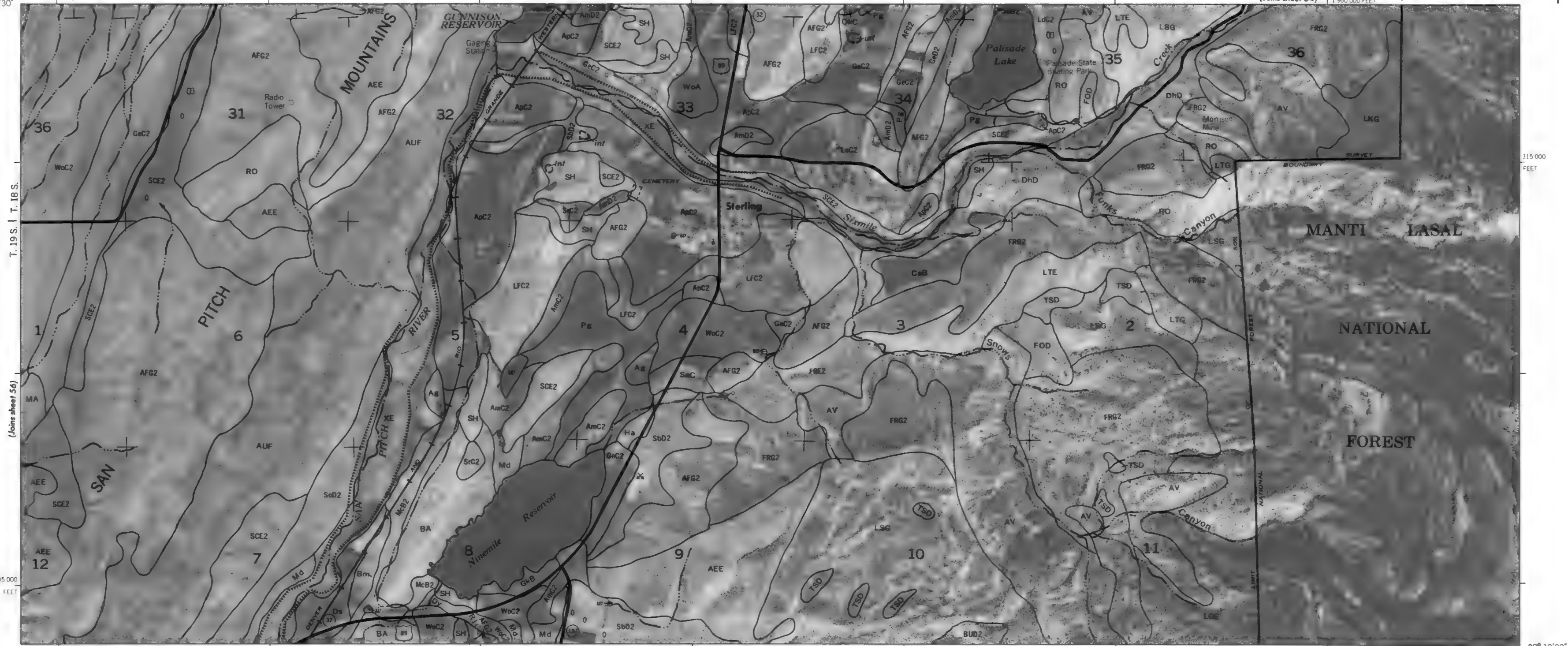
SANPETE VALLEY AREA, UTAH, PARTS OF UTAH AND SANPETE COUNTIES — SHEET NUMBER 56





111° 45' 00" R. 1 E. | R. 2 E.
39° 12' 30"

(Joins sheet 54) | 1 960 000 FEET | R. 2 E. | R. 3 E.



T. 19 S. | T. 18 S.

(Joins sheet 56)

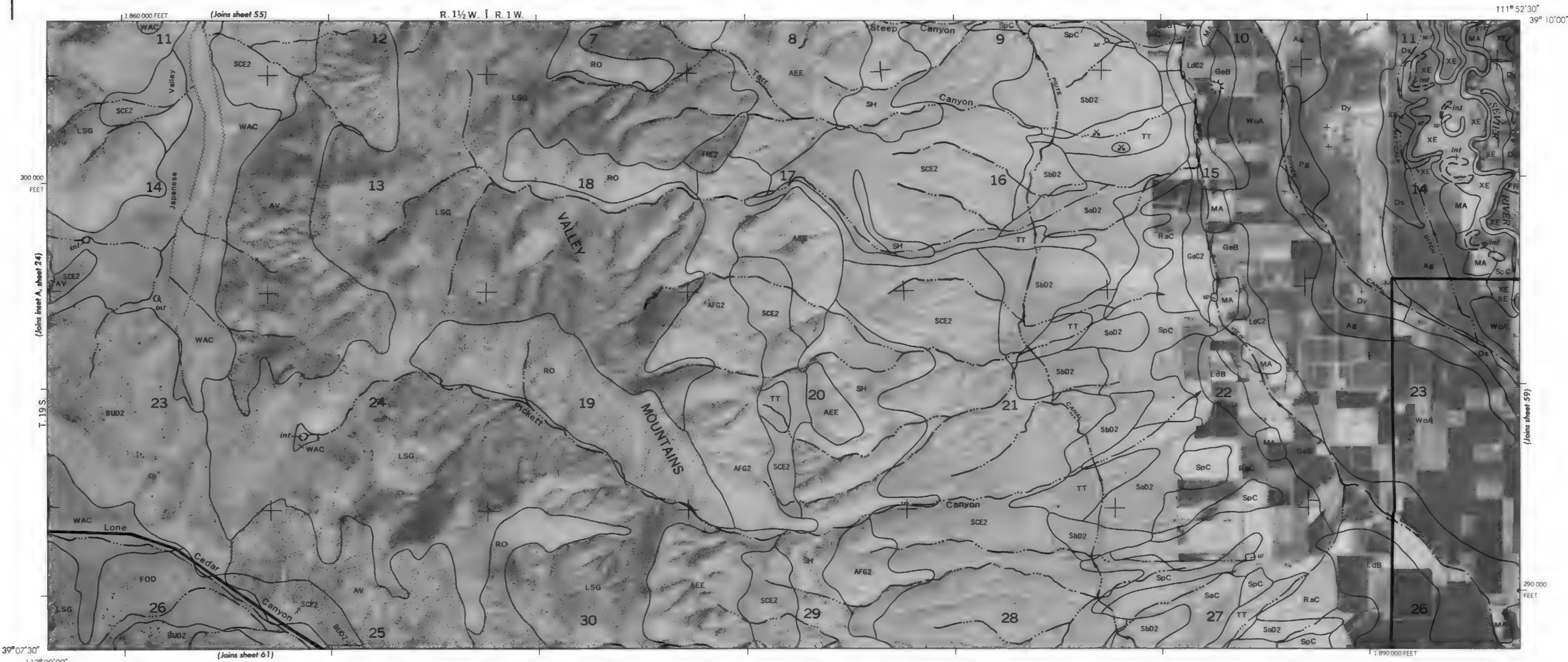
305 000
FEET

315 000
FEET

(Joins sheet 60)

39° 10' 00"
111° 37' 30"





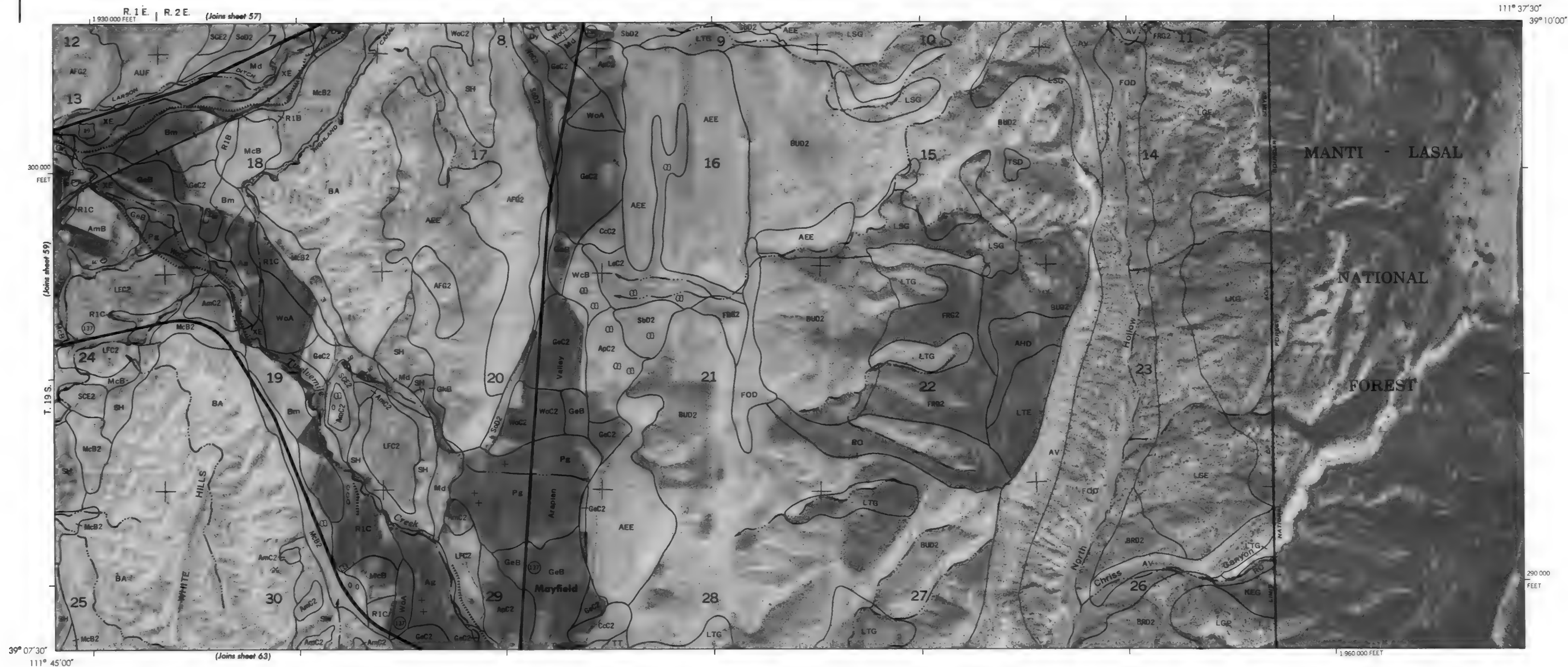
39° 07' 30" 112° 00' 00"

111° 52' 30" 39° 10' 00"



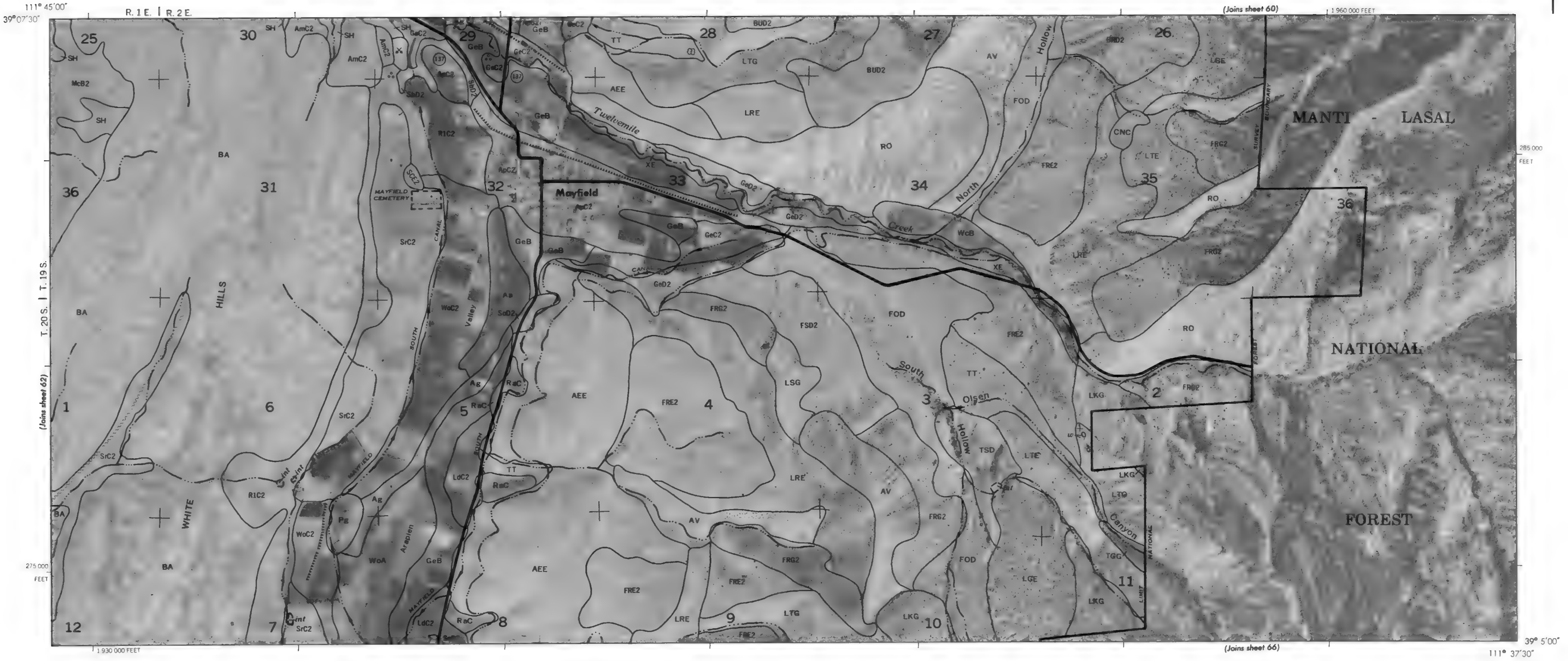
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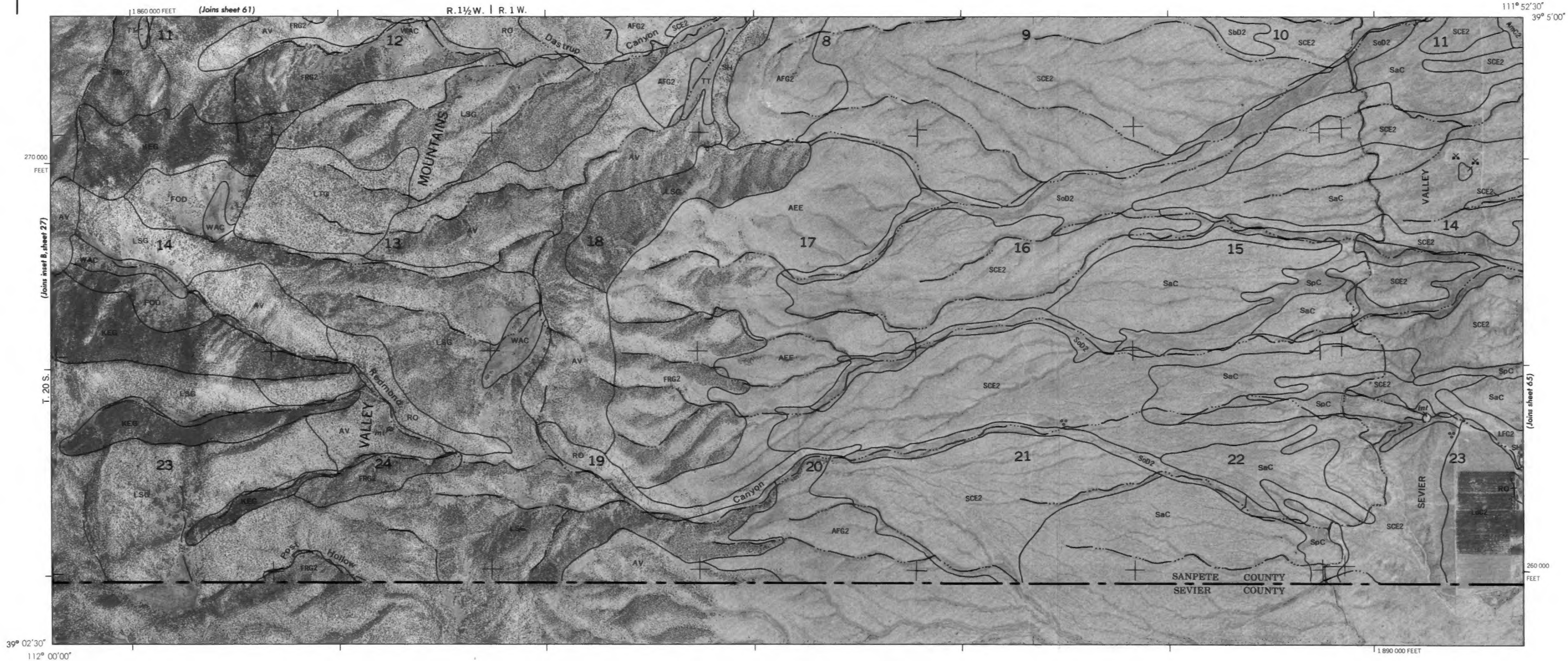














111° 52' 30"
39° 5' 00"

R. 1 W. | R. 1 E.

(Joins sheet 62)

1 925 000 FEET



270 000
FEET

(Joins sheet 66)

T. 20 S.

39° 02' 30"
111° 45' 00"

(Joins sheet 67)

